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RADFORD'S CEMENT HOUSES

AND HOW TO BUILD THEM

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CEMENT HOUSES

AND

HOW TO BUILD THEM

Illustrated Details of Construction, Standard Specifications for Cement, Standard Specifications for Concrete Blocks, General Information Concerning Waterproofing, Coloring, Paving, Reinforcing, Foundations, Walls, Steps, Sewer Pipe, Tile, Chimneys, Porches, Floors, Use of Concrete on the Farm, Etc.

PERSPECTIVE VIEWS AND FLOOR PLANS

OF

CONCRETE BLOCK AND CEMENT PLASTER HOUSES

BY

WM. A. RADFORD

PUBLISHED BY

THE RADFORD ARCHITECTURAL COMPANY

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PREFACE.

The history of the human race represents no parallel to that of the marvelous development during the present generation of home architecture by the use of concrete hollow blocks and cement plaster. Signs are everywhere seen that this form of construction will continue to be in popular favor. Home builders the world over are hungry for information about cement houses. The demand for such information is unprecedented in the annals of building. "Tell us how to build a home of cement" is a popular cry heard throughout the land.

It is to meet this great demand that this book is presented to the building public. As it has been prepared by the most expert and skilled architects and cement experts of the country it is certain that the full requirements of those who want a home built of cement in any of the forms—blocks, monolithic, reinforced or plaster—have been met in its pages. The purpose has been to give the public the best and the most artistic creations in cement architecture possible to produce. That success has crowned the efforts a perusal of these pages will reveal. The purpose has been not only to show beautiful designs and plans for houses of cement construction, but also to tell in plain language divested of high sounding and technical words exactly how each part of the work should be done. To that extent the volume will serve as a text book on the subject.

We take it for granted that the reader is beginning at the bottom and seeks to know all about cement insofar as it concerns him in his desire to build a cement house. Books dealing with a special subject too often are of a purely technical character. We aim here to present the subject simply and in a manner that will be of practical use to the man who intends to build a moderate cost house.

The beginning of the twentieth century has witnessed rapid strides in the use of cement and concrete in a thousand and one departments of human activity. Nor is it difficult to find the cause. The scarcity of timber and lumber is the principal cause outside of all considerations of concrete in its value of itself as constructive material. The shortage of lumber and timber simply has brought the world again to a realization of its utility sooner than would have been the case otherwise.

America is fast losing the forest primeval. One needs only to take a short trip through northern Michigan, Wisconsin, or any of the other states, to realize the truth of this statement. Where once stood vast forests of pine hundreds of miles in extent now not one tree remains. The forests of the south are fast being denuded, and it will not be long before the mountains of the west will be bare.

In the preparation of this work all possible sources of accurate information have been drawn upon, so that the volume is presented as an epitome of all the latest investigations on the subject of cement and concrete. We are especially indebted to the various cement companies who have granted us permission to make use of the pamphlets and literature which they have sent out to the trade from time to time for educational purposes. Acknowledgment also is due the national organization of the cement manufacturers for the aid given in the annual reports and bulletins sent out.

We wish to take this opportunity also to thank all the machine manufacturers, the cement manufacturers, the architects and others who have rendered valuable assistance to us in the compilation of this book, and who have so generously and kindly loaned us photographs by means of

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which the builder will be able to see exactly how a house will look when completed. We have long been urged by the machinery manufacturers, the cement manufacturers, construction companies and many others to publish a book on cement houses and how to build them, and we at last consented to produce such a volume, believing the time to be ripe for such a publication and realizing the urgent necessity for it at this stage of the development of the cement industry.

We take this occasion to commend to the reader a candid study of cement and its uses as here set forth, believing most sincerely in its adaptability to any form of building construction. We do this with no intent to belittle other standard materials, for there is room for all.

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CEMENT HOUSES AND HOW TO BUILD THEM.

Introductory Notes.—Part I.

The practical workman who is interested mainly in the every-day problems that come before him in the handling of cement has little time for the history of the industry, but a brief outline of the ancient uses of this useful material will not be amiss for those who desire to be thoroughly posted.

The use of cement is by no means a modern method of construction. The Romans used it as far back as 500 B. C., both in the building of roadways and structures. The very word "concrete" itself is of Latin origin, meaning a collection of materials bound together by a cementing matrix.

One of the most famous of the ancient monuments that was made of cement was the Appian Way. This was the oldest of the Roman highways, having been started by Appius Claudius Caius about the third century before the Christian era. It extended from Rome to Capua and later it was built to Tarentum and Brundisium.

Another use made of cement by the Romans was its application in the construction of aqueducts, many of them several miles long. Many residences of the nobles were constructed of concrete unfaced by brick or stone. Wood framing was used in the casting of walls in much the same manner as the methods that are in use today.

Professor Middleton in his first book, "Ancient Rome," states that the entire upper floor of the Antrium' Vesta was formed of one great slab of concrete fourteen inches thick and having a span of twenty feet supported on its edges and having no intermediate supports.

The Romans used concrete also in the building of the Pantheon, which was constructed about the time of Christ.

Of the antiquity of the use of manufactured blocks there seems to be no doubt. It is called a modern industry, but it has been proved that the Egyptians used a porous lava that contained hydraulic properties and the basic element necessary in the making of cement similar to our Portland of today. The sarcophagus in which they placed their dead was made of manufactured stone. It has been pretty definitely decided that at least the upper portions of the Egyptian pyramids were formed in the same manner, and the massive blocks of stone that have baffled the past ages by the mystery of their transportation to such elevations probably were borne to their destination by the pailful. As a further proof that these blocks were of man's formation breakages in some of them reveal small pieces of wood embedded in the mass.

The early races in other parts of the world were familiar with and made use of cement in building. The Peruvian builders in the days of the Incas in Peru used this material, impelled probably by the necessity of adopting a form of construction that would withstand earthquakes and volcanic tremors. Some of these structures, though built many centuries ago, have endured till today. In Spain and other countries of the old world are found abundant evidences of the ancient use of this material in forms that have survived the ravages of time and the elements. Probably the first modern use of the cement block in the construction of any great public work was its employment in the construction of the Suez Canal. There blocks weighing as much as twenty tons were used. So it is readily seen that the growing use of cement today is nothing new, but simply a return to first principles.

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So rapid has been the advancement in the use of concrete in the many forms for which it is adapted that even now it is considered indispensable by architects, builders and engineers.

Why You Should Build with Cement.

The imperishability and the artistic qualities of a well built cement residence are unquestioned. For the durability of this wonderful material we only have to visit some of the ancient buildings of the Eternal City to see a verification of its lasting quality. Here are the principal reasons why you should build your home of cement:

A cement house will last practically forever.

It can be made fireproof.

It is warmer in winter and cooler in summer.

It requires no paint and no repairs.

It is earthquake proof and defies the elements.

It is cheaper than any other form of construction.

Finally, and most important of all, a well built, stylish cement house always is salable in case you should want to dispose of it.

In constructive work the primal factor is durability outside of all considerations of beauty and form. Buildings or walls made of cement are independent of the painter. No patching has to be done. All is imperishable. The home builder is awakening to the truth of these facts and the architect is adapting himself to the new conditions.

Definitions of Terms Used.

To the practiced workman the following list of definitions is not necessary. But for the benefit of those readers who are seeking their first knowledge in the handling of cement and concrete these definitions are intended as the ground work on which to make their progress in the study easier and more comprehensive. To that end the definitions should be thoroughly mastered and understood before proceeding.

Aggregates. Gravel, crushed stone or other substances used in concrete and joined in one mass by cement.

Concrete. A building or constructive material made of sand, cement and aggregates.

Artificial Stone. A stone made of sand, aggregates, etc., mixed with adhesive material and hardened and used instead of natural stone.

Hollow Concrete Blocks. A block used in the construction of hollow concrete walls, made of cement, sand and crushed stone or gravel.

Activity. The chemical action of cement upon the addition of water.

Crazing. The checking or cracking of the surface of artificial stone, concrete, etc.

Tamping. The pounding of concrete to reduce voids and force the aggregates as closely together as possible into a compact mass.

Voids. The space or interstices between the constituent parts of aggregates.

Monolith. A term applied to single piece work or walls built with concrete between frames; its literal meaning is "one stone."

Crystallization. The chemical action of cement when coming in contact with water, commonly known as the setting of cement.

Efflorescence. The formation of a white or grayish crust on the surface of stone, brick, etc.

Soakage. The absorption of water by hardened concrete, stone, brick, etc.

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Soundness. The non-expansion quality of cement.

Wearing Surface. The top coat of cement and sand on walks, stairs, platforms or verandas—any surface that is exposed to wear by being walked upon or brought into contact with outside forces.

Molds. Frames used to shape concrete into forms.

Ramming. The pounding or beating of concrete to compress the mass and force out the superfluous water.

Screeds. Levels used for guides and bearings for leveling and ruling off.

Reinforced or Reinforcing. The use of steel rods in monolithic walls to increase the strength.

Firmness. The pulverized condition of cement.

Porous. The quality of possessing pores or minute voids.

Tensile Strength. The holding power or measure of adhesiveness of concrete or cement mortar.

Waterproofing. A dense coating of cement mortar over concrete surfaces to prevent the absorption of moisture into the interior of the mass.

Core. The mold used to form the hollowed-out part of a cement or concrete block.

Stonette. A composition of Portland cement and fine aggregate.

Subfoundation. The first coat of material placed in excavation ground for sidewalks, floors, etc.; usually it is cinders.

Stucco. Cement mortar or gypsum plaster mixture used in the exterior finishing of buildings.

Pebble Stone Finish. The finish given stucco work by spreading small pebbles over the surface.

Frost Line. The average level to which frost penetrates into the ground. It varies in different localities.

Treads and Risers. The tread is the horizontal part of a step. The riser is the vertical part of the step.

Centers. The distance between the center of one joist or beam to the center of another.

Different Kinds of Cement.

Portland cement is produced by intimately mixing one part of limestone, marl or chalk with three parts of cement rock, clay, shale or slag, burning the two elements to semi-fusion and grinding the clinker resulting to an impalpable powder. The feature that distinguishes Portland cement from all others is the intense heat at which the pulverized raw materials are calcined and the accurate proportioning of the essential elements entering into its composition. These elements are lime, silica, alumina and oxide of iron and there must be in the finished product not less than 1.7 times as much lime by weight as of the other elements mentioned.

Puzzolan Cement. The cement used by the Romans was known as Puzzolan cement. It was made for the most part of lime and volcanic dust. In America for the manufacture of cement of this kind slag and lime are used. The materials in it are not calcined after mixing, but are ground exceedingly fine. Its specific gravity is lower than that of Portland cement and it is of a pinkish hue in color. It is not used ordinarily for dry work or for exposure above ground.

Natural Cement. In various parts of the United States there is a natural rock from which the so-called natural cement is produced. The temperature used in its manufacture is not as high as that required for the calcination of Portland cement. This kind of cement is well adapted for use in the interior of heavy masonry.

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PART II.

Specifications for Portland Cement.

The Standard Specifications for Cement, as adopted by the American Society of Civil Engineers, are as follows:

Portland Cement — Definition. This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent has been made subsequent to calcination.

Specific Gravity. The specific gravity of the cement, thoroughly dried at 100 degrees C., shall be not less than 3.10.

Fineness. It shall leave by weight a residue of not more than 8 per cent on the No. 100, and not more than 25 per cent on the No. 200 sieve.

Time of Setting. It shall develop initial set in not less than thirty minutes, but must develop hard set in not less than one hour, nor more than ten hours.

Tensile Strength. The minimum requirements for tensile strength for briquettes one inch square in section shall be within the following limits, and shall show no retrogression in strength within the periods specified:

Age. Neat cement.	Strength. Pounds.
24 hours in moist air	150-200
7 days (1 day in moist air, 6 days in water)	450-550
28 days (1 day in moist air, 27 days in water)	550-650
One part cement, three parts sand.	
7 days (1 day in moist air, 6 days in water)	150-200
28 days (1 day in moist air, 27 days in water)	200-300

Constancy of Volume. Pats of neat cement about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(b) Another pat is kept in water maintained as near 70 degrees F. as practicable, and observed at intervals for at least 28 days.

(c) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

Sulphuric Acid and Magnesia. The cement shall not contain more than 1.75 per cent of anhydrous sulphuric acid (SO_3), nor more than 4 per cent of magnesia (MgO).

How to Test Cement.

W. Purves Taylor, engineer of the Philadelphia Municipal Testing Laboratories, has contributed to the industry a number of simple tests that in a general way are suited to the requirements of the user of cement. The matter of the quality of the cement to be used for any given purpose is an exceedingly important factor to be considered and too often is lost sight of. Mr. Taylor's methods are given as follows:

Soundness. Take about half a pound of cement, place it on a clean surface of metal or glass and form it into a crater. Into the center of the crater pour about a fifth of its weight of water and mix thoroughly by hand or with a trowel for a couple of minutes until a stiff and uniform paste is obtained. Make a ball of the paste about 2 inches in diameter and drop it on the table from a height of about 2 feet. If the ball flattens more than half its depth the paste is too wet; if it cracks badly it is too dry. Add more cement or more water,

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mix thoroughly and test until the right consistency is obtained, then mold two balls about 2 inches in diameter.

Take a tin can, which has a tightly fitting cover, and bend into it a piece of wire netting, as shown in Fig. 1, about 2 inches from the bottom. Put about an inch of water in the bottom of the can, place one of the balls on the netting, cover the can, and put it away in a cool place for twenty-four hours. Then fill the can with water to cover the ball, remove the cover and

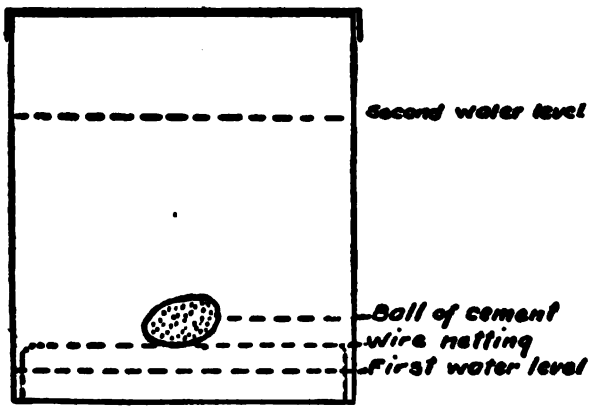

Fig. 1—Method of testing for soundness.

place it on a stove at such a heat that the water will boil in about half an hour. Let it boil gently then for three hours. Have a second vessel of boiling water beside the can and as the water evaporates replace it with the boiling water. Never add cold water. After boiling three hours, remove the ball and examine it.

A good Portland cement will always pass this test, and the ball will remain sound and hard. If the ball is disintegrated, or if it is checked or cracked, it generally indicates inferior quality and untrustworthy material. Sometimes failure in boiling is caused by the material being too fresh, and a second test made a month or so later will pass, showing that the expansive elements have become hydrated and thus inert. In general, however, it is on the safe side never to use cement that fails in boiling. If it fails at first store it away for a month and then test again. If it still fails it is better not to use it.

Time of Setting. Put the second ball, made as previously described, in a place protected from the sun or any other source of heat, and from any strong current of air. At the end of twenty minutes examine it, then put it away and examine it again in ten hours. The ball at twenty minutes should be still soft and pliable, damp on the surface, and should not feel warm. At ten hours it should be dry, firm and hard enough so that a firm pressure of the thumb nail will make no impression on it. If the cement begins to harden or feel warm in less than twenty minutes, it is generally inadvisable to use it, since setting will have begun before the mortar or concrete is molded, and the result will be a weak and easily disintegrated product. It is, of course, possible to retemper such cement and obtain excellent results, but this process requires considerable skill and experience and therefore is not usually to be recommended. Quick setting cement often becomes slow on a storage of a month or two, so that it is better to keep this material than to attempt to use it earlier at the risk of poor results. A cement that does not harden in ten hours may ultimately give good results, but the slow setting will much delay the progress of the work and may cause injury in removing the molds or striking the centers. Safe practice will require cement to set between the stated limits.

Purity. Take as much cement as may be lifted on a five-cent piece and place it in a china or glass dish. Pour on it a mixture of one part of water and three parts of muriatic acid, using a quantity equal to about three times the volume of cement. Pure Portland cement effervesces violently a second or two and then forms a yellow-

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ish jelly. A continued effervescence shows adulteration with limestone or natural cement. Cinders or sand is shown in a sediment at the bottom of the jelly. The presence of slag is shown by the characteristic putrid odor of hydrogen sulphide. Cement containing any of these adulterations should not be used.

Strength. It is very difficult to determine the strength of a cement mortar by any simple method and obtain results of even approximate accuracy. The following, however, is probably the best method: Make a mold, as shown in Fig. 2, of a planed board and some one inch strips of wood. Fasten the top strip to the board and place the others on loosely, holding them in place by the wedges at the bottom, thus forming molds for three prisms of

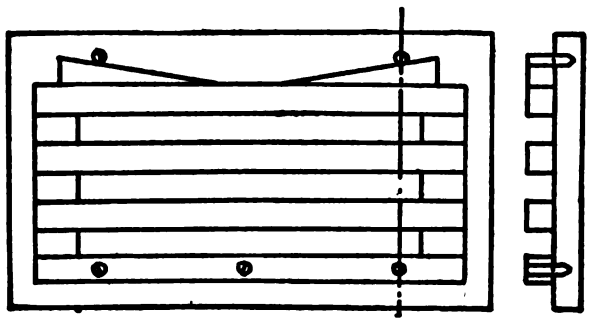

Fig. 2—Molds for simple testing apparatus.

mortar 1 inch by 1 inch by 12 inches long. Take special care that the cross sections of the prisms are exactly one inch.

Take mortar from the mixing box, or make some of one part cement and three parts sand, thoroughly mixed dry and then wetted to form a stiff mortar, and fill the molds, pressing the material in firmly and smoothing the tops with a trowel. The molds should be oiled slightly to prevent mortar from sticking. Put the mold away in a cool and, if possible, damp place for twenty-four hours. Then remove the prisms of mortar and place them in fresh water, neither hot nor cold, for six or for twenty-seven days. Any prisms that are chipped or otherwise defective should be discarded. Make the apparatus shown in Fig. 3 with a board, a round piece of wood about an inch in diameter, and a pail. The bottom knife edges are made by cutting the round piece of wood in half, and are fastened to the board exactly 10 inches apart. center to center. The center knife edge is a round piece of wood from which a pail is suspended by a cord.

When the test pieces are seven or twenty-eight days old place them, still wet, on the apparatus as shown in the cut, taking care that the upper strip is exactly in the center and at right angles with the prism. Adjust the pail so that it is just off the ground and exactly under the specimen,

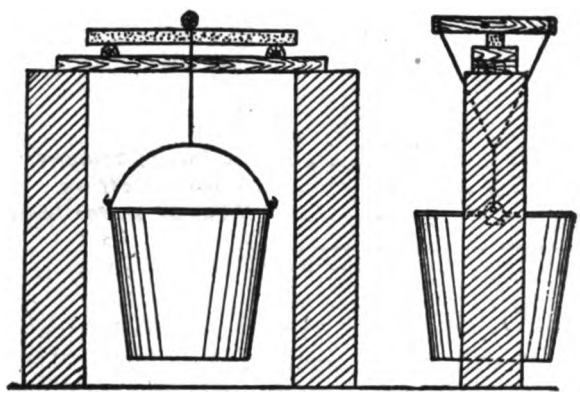

Fig. 2—Method of testing strength.

and then slowly pour sand into it until the prism breaks. Carefully weigh the bucket with the cord and strip still attached. If the prism is not exactly one inch square, correct the weight by dividing it by the product of its width times the square of its depth in inches.

The approximate strength of the mortar may then be computed as follows:

Tensile strength equals center load multiplied by 10.

Compressive strength is load multiplied by 50.

If the average of three prisms tested in this manner shows a tensile strength of less than 120 pounds at seven days or 180

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pounds at twenty-eight days, on 1:3 mortars, something is radically inferior and wrong with either the cement or the sand, and the fault should be thoroughly investigated.

Tests made by this method are, of course, far from being accurate, but they nevertheless give a very fair indication of the value of the material. In determining the relative value of different sands intended for use they will often give most valuable and useful information. These tests described are, of course, crude in the extreme, but are vastly superior to no tests at all, and should be of much assistance to the small user in securing good material. Insist on cement that will boil and set normally, and most of the dangers of inferior cement will be avoided.

Another simple method of testing by which the user may ascertain the soundness of the cement he purposes to use is as follows: Make three cakes of cement, thicker in the middle than on the edges. Allow one to remain in moist air for twenty-four hours and then steam it four hours. The second cake should be exposed in moist air and the third be immersed in water. The results in the case of the second and third cakes should be noted at intervals during twenty-eight days. If the cement is sound it will not disintegrate. But if it shows expansion cracks on the edges of any of the cakes it is not sound.

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PART III.

Concrete Block Architecture.

Concerning the new architecture that the adoption of the building block and concrete construction involve, William Price, in a paper read before the Association of American Portland Cement Manufacturers, said:

"In block building, whether of stone, brick or other material, the joints are the essential elements of building, and as such should become the essential elements of design to be accentuated rather than hidden, and in all good architectural design you will find recognition of this fact. Concrete is built with shovel and trowel, and its proper ornamentation should be either cast in molds as built, or such as can be run or fashioned on the work, with the addition of such color ornament as may be obtained by the use of terra cotta or other protecting material used as wall copings, roofs, piers, caps, etc., and such other flat color ornaments as may be produced with tiles, marble, glass or other material which is evidently applied to the surface. It is evident that this would and should be a wide departure from classic forms and accepted styles; that it means, in fact, a new architecture, although it will not be necessary to abandon all precedent. We shall want walls, windows and doors in any case, and must learn to build them in their accepted forms. But in a material so plastic the forms of openings and mouldings may be expected to vary much from those necessary to an architecture dependent on arches and lintels. There is more to be learned in the Spanish and the Mexican varieties of Spanish, than any other accepted types. Their plastered walls, tile roofs and wall copings suggest concrete more than they do brick, and their domes and curved pediments are already suggestive of plastic rather than block construction."

Concrete Building Blocks.

With all the manifold uses to which cement is being put in the various forms of constructive work in the country the building block stands out more prominent than any other feature of the concrete industry. It is without question the most popular form in which cement is brought before the public, because it appeals to the home builder and to the contractor.

The many machines on the market for the making of building blocks and the advantages claimed for each have attracted many men to the industry and unfortunately through ignorance poor blocks have been produced in many cases, but this is not the fault of concrete.

The hollow concrete block, properly made, is an ideal material for exterior walls for residences and at the price asked for lumber today is fully as cheap. Frame dwellings are perishable. Those of cement blocks, properly made, are practically imperishable and fire proof. Numerous instances are at hand of laymen buying cement block machines and with intelligence making blocks at odd times sufficient to build a home. There is no reason why this cannot be done by thousands.

Sometimes is heard the complaint that blocks are porous. This fault is due entirely to errors in the making of the blocks. When made properly they are all that could be desired. Being hollow, they provide an air space that makes the structure warmer in winter and cooler in summer, besides providing a space for the carrying of electric wires and heating flues.

The general principles of concreting

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apply to these blocks. The aggregate should not consist of stone or gravel larger than half an inch. The blocks are given an ornamental facing with cement mortar and the rules for the making of them are given by the many houses that sell the machines.

A Word of Caution.

Working with concrete is not an occupation in which the layman can experiment inexpensively. The general rule may well be laid down: Do not purchase an ounce of cement or stone till you know exactly what you are going to do and how you are going to do it. Familiarity with the rules governing the mixing and the proportions and quantities are absolutely essential to success. This is true of all mechanics and especially true of concrete work. It is not necessarily true that the worker must know the scientific and chemical properties of the work, but he must know the "how." Of course it is better if he has a knowledge of the chemistry of concrete work, but he may produce good results by merely following exactly the formula that has proved effective and advantageous in the hands of experts. These general remarks are made for the benefit of the novice who is thinking of using concrete in the building of a house or in the improvement of a home he already possesses. So bear these things in mind:

Do not guess as to measurements.

Do not use less cement than any formula calls for.

Mix thoroughly—and a little more.

Put your concrete in place at once.

Use only clean water, and clean gravel or stone.

These five "musts" kept constantly in mind and in practice are the foundations of success. To ignore any one of them spells failure.

General Rules.

There are a few very important rules that the cement block maker must have always in mind to assure the production of the best possible product.

When operating in the open air cover the blocks with burlap or any light cloth to protect them from air drafts and the sunlight.

Never use cement that has once set. Never redampen a composition that has commenced hardening. But if you have such material let it harden and crush it, using it as you would crushed stone in the aggregate.

Never neglect sprinkling. The more nearly like a mist the spray is the better for the stone.

While blocks are in the plastic state they must be handled with extreme care, as sudden jars, resting on an uneven bed or being even slightly rocked has a tendency to crack the work in its most vital places.

The best and easiest way to mend defects in artificial stone is to make the entire block over again, as patch work will sooner or later be easily seen.

Standard Specifications for Blocks.

We recommend to the home builder the Standard Specifications for Concrete Hollow Blocks as revised, corrected and adopted by the National Association of Cement Users. These specifications represent the results of the careful investigations, experiments and experiences of the most expert men in the concrete hollow-block industry, and if the rules laid down by them are carefully followed the best blocks possible to produce will be the result. The specifications are as follows:

Concrete Hollow Blocks made in accordance with the following specifications, and meeting the requirements thereof, may

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be used in Building Construction, subject to the usual form of approval, required of other materials of construction, by the Bureau of Building Inspection.

1. Cement. The cement used in making sand blocks shall be Portland Cement, capable of passing the requirements as set forth in the "Standard Specifications for Cement," by the American Society for Testing Materials.

2. Sand. The sand used shall be suitable siliceous material, passing the one-fourth inch mesh sieve, clean, gritty and free from impurities.

3. Stone or Coarse Aggregate. This material shall be clean broken stone, free from dust, or clean screened gravel passing the three-quarter (¾) inch, and refused by the one-quarter (¼) inch mesh sieve.

4. Unit of Measurement. The barrel of Portland Cement shall weigh 380 pounds net, either in barrels or sub-divisions thereof, made up of cloth or paper bags, and a cubic foot of cement shall be called not to exceed 100 pounds or the equivalent of 3.8 cubic feet per barrel. Cement shall be gauged or measured either in the original package as received from the manufacturer, or may be weighed and so proportioned; but under no circumstances shall it be measured loose in bulk.

5. Proportions. For exposed exterior or bearing walls: (a) Concrete hollow blocks, machine made, using semi-wet concrete or mortar shall contain one (1) part cement, not to exceed three (3) parts sand, and not to exceed four (4) parts stone, of the character and size before stipulated. When the stone shall be omitted, the proportions of sand shall not be increased, unless it can be demonstrated that the percentage of voids and tests of absorption and strength, allow in each case of greater proportions, with equally good results.

(b) When said blocks are made of slush concrete, in individual molds and allowed to harden undisturbed in same before removal, the proportions may be one (1) part cement to not to exceed three (3) parts sand and five (5) parts stone, but in this case also, if the stone be omitted the proportion of sand shall not be increased.

6. Mixing. Thorough and vigorous mixing is of the utmost importance.

(a). Hand Mixing. The cement and sand in correct proportions shall first be perfectly mixed dry, the water shall then be added carefully and slowly in proper proportions, and thoroughly worked into and throughout the resultant mortar; the moistened gravel or broken stone shall then be added, either by spreading same uniformly over the mortar, or spreading the mortar uniformly over the stones, and then the whole mass shall be vigorously mixed together until the coarse aggregate is thoroughly incorporated with and distributed throughout the mortar.

(b). Mechanical Mixing. Preference shall be given to mechanical mixers of suitable design, and adapted to the particular work required of them; the sand and cement, or sand and cement and moistened stone shall, however, be first thoroughly mixed before the addition of water, and then continued until the water is uniformly distributed or incorporated with the mortar or concrete:—Provided, however, that when making slush or wet concrete (such as will quake or flow) this procedure may be varied with the consent of the Bureau of Building Inspection, Architect or Engineer in Charge.

7. Molding. Due care shall be used to secure density and uniformity in the blocks by tamping or other suitable means of compression. Tamped blocks shall not be finished by simply striking off with a straight edge, but, after striking off, the

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top surfaces shall be trowelled or otherwise finished to secure density and a sharp and true arris.

8. **Curing.** Every precaution shall be taken to prevent the drying out of the blocks during their initial set and first hardening. A sufficiency of water shall first be used in the mixing to perfect the crystallization of the cement, and, after molding, the blocks shall be carefully protected from wind currents, sunlight, dry heat or freezing, for at least five (5) days, during which time additional moisture shall be supplied by approved methods, and occasionally thereafter until ready for use.

9. **Aging.** Concrete hollow blocks in which the ratio of cement to sand be one-third (1-3), (one part cement to three parts sand,) shall not be used in the construction of any building in the (City) of ———— (Town) of ———— until they have attained the age of not less than three (3) weeks.

Concrete hollow blocks in which the ratio of cement to sand be one-half (1-2) (one part cement to two parts sand) may be used in construction at the age of two (2) weeks, with the special consent of the Bureau of Building Inspection and the Architect or Engineer in Charge.

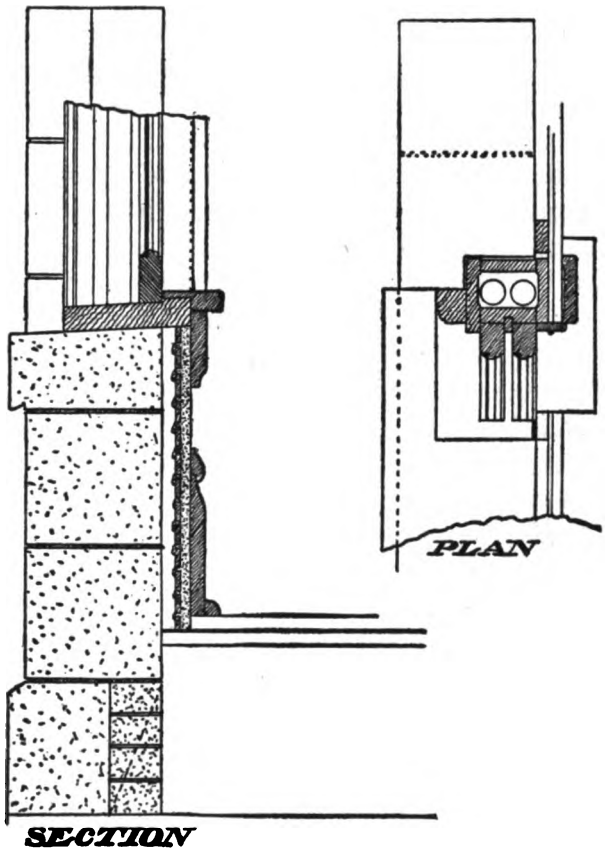
Special blocks of rich composition, required for closures, may be used at the age of seven (7) days with the special consent of the same authorities.

The time herein named is conditional, however, upon maintaining proper conditions of exposure during the curing period.

10. **Marking.** All concrete blocks shall be marked for purposes of identification, showing name of manufacturer or brand, date (day, month and year) made, and composition or proportions used, as, for example, 1-3-5, meaning one cement, three sand and five stone.

11. **Thickness of Walls.** The thickness of bearing walls for any building where concrete hollow blocks are used, may be ten (10) per cent less than is required by law for brick walls. For curtain walls, or partition walls, the requirements shall be the same as in the use of hollow tile, terra cotta or plaster blocks.

12. **Party Walls.** Hollow concrete blocks shall not be permitted in the construction of party walls, except when filled solid.



Work About Windows.

13. **Walls, Laying of.** Where the face only is of hollow concrete block, and the backing is of brick, the facing of hollow block must be strongly bonded to the brick either with headers projecting four (4) inches into the brick work, every fourth course being a heading course, or with approved ties; no brick backing to be less

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than eight (8) inches. Where the walls are made entirely of concrete blocks, but where said blocks have not the same width as the wall, every fifth course shall extend through the wall, forming a secure bond, when not otherwise sufficiently bonded. All walls, where blocks are used, shall be laid up with Portland Cement Mortar.

14. Girders or Joists. Wherever girders or joists rest upon walls so that there is a concentrated load on the block of over two (2) tons, the blocks supporting the girder or joists must be made solid for at least eight (8) inches from the inside face. Where such concentrated load shall exceed five (5) tons, the blocks for at least three courses below, and for a distance extending at least eighteen (18) inches each side of said girder, shall be made solid for at least eight (8) inches from the inside face. Wherever walls are decreased in thickness, the top course of the thicker wall shall afford a full solid bearing for the webs or walls of the courses of blocks above.

15. Limit of Loading. No wall, nor any part thereof, composed of concrete hollow blocks, shall be loaded to an excess of eight (8) tons per superficial foot of the area of such blocks, including the weight of the wall, and no blocks shall be used in bearing walls that have an average crushing at less than 1,000 pounds per sq. in. of area, at the age of twenty-eight (28) days; no deduction to be made in figuring the area for the hollow spaces.

16. Sills and Lintels. Concrete sills and lintels shall be reinforced by iron or steel rods in a manner satisfactory to the Bureau of Building Inspection, and the Architect or Engineer in Charge, and any lintels spanning over four feet, six inches shall rest on block solid for at least eight inches from the face next the opening and for at least three courses below the bottom of the lintel.

17. Hollow Space. The hollow space in building blocks, used in bearing walls, shall not exceed the percentage given in the following table for different height walls, and in no case shall the walls or webs of the block be less in thickness than one-fourth their height. The figures given in the table represent the percentage of such hollow space for different height walls.

Stories.	1st.	2d.	3d.	4th	5th.	6th.
1 and 2	33	33	..	..	..	..
3 and 4	25	33	33	33	..	..
5 and 6	20	25	25	33	33	33

18. Application for Use. Before any such material be used in buildings, an application for its use and for a test of the same must be filed with the Bureau of Building Inspection. In the absence of such a Bureau the application shall be filed with the Chief of any Department having such matters in charge. A description of the material and a brief outline of its manufacture and proportions used must be embodied in the application. The name of the firm or corporation, and the responsible officers thereof, shall also be given, and changes in same thereafter promptly reported.

19. Preliminary Test. No hollow concrete blocks shall be used in the construction of any building unless the maker of said blocks has submitted his product to the full tests required herein, and placed on file with the Bureau of Building Inspection, or other duly authorized official, a certificate, from a reliable testing laboratory, showing that representative samples have been tested and successfully passed all requirements hereof, and giving in detail the results of the tests made.

No concrete blocks shall be used in the construction of any building until they have been inspected and approved, or, if required, until representative samples be tested and found satisfactory. The results of all tests made, whether satisfactory or not, shall be placed on file in the Bureau of

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Building Inspection. These records shall be open to inspection upon application, but need not necessarily be published.

20. Additional Tests. The Manufacturer and User of such hollow concrete blocks, or either of them, shall at any and all times, have made such tests of the cements used in making such blocks, or such further tests of the completed blocks, or of each of these at their own expense, and under the supervision of the Bureau of Building Inspection, as the Chief of said Bureau shall require.

In case the result of tests made under this condition should show that the standard of these regulations is not maintained, the certificate of approval, issued to the Manufacturer of said blocks, will at once be suspended or revoked.

21. Certificate of Approval. Following the application called for in clause No. 18, and upon the satisfactory conclusion of the tests called for, a certificate of approval shall be issued to the maker of the blocks by the Bureau of Building Inspection. This certificate of approval will not remain in force for more than four months, unless there be filed with the Bureau of Building Inspection, at least once every four months following, a certificate from some reliable physical testing laboratory showing that the average of at least three (3) specimens tested for compression, and at least three (3) specimens tested for transverse strength, comply with the requirements herein set forth. The said samples to be selected by a Building Inspector, or by the Laboratory, from blocks actually going into construction work.

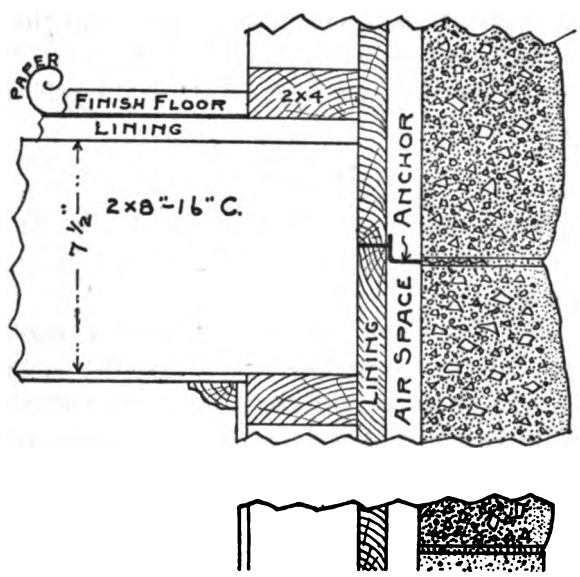

Fig. 19—Showing the details of construction at the second floor level. Note the air space. This detail provides also for an anchored wall.

22. Test Requirements. Concrete hollow blocks must be subjected to the following tests; Transverse, Compression and Absorption, and may be subjected to the Freezing and Fire Tests, but the expense of conducting the Freezing and Fire Tests will not be imposed upon the Manufacturer of said blocks.

The test samples must represent the ordinary commercial product, of the regular size and shape used in construction. The samples may be tested as soon as desired by the applicant, but in no case later than sixty days after manufacture.

Transverse Test. The modulus of rupture for concrete blocks at 28 days must average one hundred and fifty, and must not fall below one hundred in any case.

Compression Test. The ultimate compressive strength at 28 days must average one thousand (1,000) pounds per square inch, and must not fall below seven hundred in any case.

Absorption Test. The percentage of absorption (being the weight of water absorbed, divided by the weight of the dry sample) must not average higher than 15 per cent, and must not exceed 22 per cent in any case.

23. Condemned Block. Any and all blocks, samples of which, on being tested under the direction of the Bureau of Build-

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ing Inspection, fail to stand at twenty-eight (28) days the tests required by this regulation, shall be marked condemned by the Manufacturer or User and shall be destroyed.

24. Cement Brick. Cement brick may be used, as a substitute for clay brick. They shall be made of one part cement to not exceeding four parts clean sharp sand, or one part cement to not exceeding three parts clean sharp sand and three parts broken stone or gravel passing the one-half inch and refused by the one-quarter inch mesh sieve. In all other respects, cement brick must conform to the requirements of the foregoing specifications.

Testing Concrete Hollow Blocks.

1. All tests required for approval shall be made in some laboratory of recognized standing, under the supervision of the Engineer of the Bureau of Building Inspection, or the Architect or Engineer in Charge, or all of these. The Manufacturer may be present or represented, during said tests, if he so desires. Approval tests are made at the expense of the applicant.

2. For the purposes of the tests, at least twelve (12) samples or test pieces must be provided. Such samples must represent the ordinary commercial product and may be selected from stock by the Bureau of Building Inspection, or in the absence of such a Bureau, by the Architect or Engineer in Charge.

In cases where the material is made and used in special shapes or forms, too large for testing in the ordinary machines, smaller sized specimens shall be used as may be directed.

3. In addition to the tests required for approval, the weight per cubic foot of the material must also be obtained and recorded.

4. Tests shall be made in series of at least three (3), except that in the fire tests a series of two (four samples) are sufficient.

Transverse tests shall be made on full sized samples. Half samples may be used for the crushing, freezing and fire tests. The remaining samples are kept in reserve in case duplicate or confirmatory tests be required. All samples must be marked for indentification and comparison.

5. The Transverse test shall be made as follows: The samples shall be placed flatwise on two rounded knife edge bearings set parallel seven inches apart. A load is then applied on top, midway between the supports, and transmitted through a similar rounded knife edge, until the sample is ruptured. The modulus of rupture shall then be determined by multiplying the total breaking load in pounds by twenty-one (three times the distance between supports in inches) and then dividing the result thus obtained by twice the product of the width in inches by the square of the depth in inches.

$$R = \frac{3}{2} \frac{W. l}{b\ d^2}$$

No allowance should be made in figuring the modulus of rupture for the hollow spaces.

6. The Compression Test shall be made as follows: Samples must be cut from blocks so as to contain a full web section. The sample must be carefully measured, then bedded flatwise in Plaster of Paris, to secure a uniform bearing in the testing machine, and crushed. The total breaking load is then divided by the area in compression in square inches. No deduction to be made for hollow spaces; the area will be considered as the product of the width by the length.

7. The Absorption Test shall be made as follows: The sample is first thoroughly dried to a constant weight, at not to exceed

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212 degrees F. The weight must be carefully recorded. It is then placed in a pan or tray of water, face downward, immersing it to a depth of at least two inches. It is again carefully weighed at the following periods: Thirty minutes, four hours, and forty-eight hours, respectively, from the time of immersion, being replaced in the water in each case as soon as the weight is taken. Its compressive strength while still wet, is then determined at the end of the forty-eight hours period, in the manner specified in section 6.

8. The Freezing Test shall be made as follows: The sample is immersed, as described in section 7, for at least four hours, and then weighed. It is then placed in a

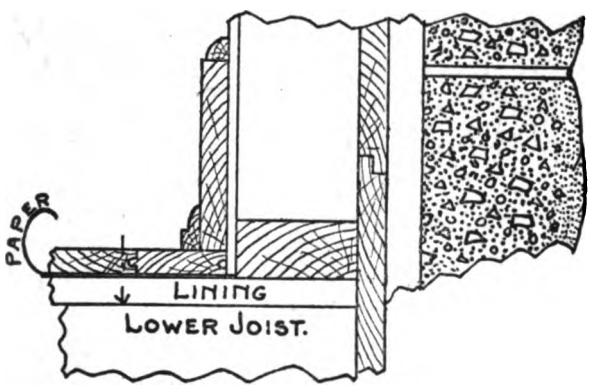

Fig. 18—Section showing the lower joist, lining, paper, flooring, base board and quarter round, sheathing and block at union of the first floor level.

freezing mixture or a refrigerator, or otherwise subjected to a temperature of less than 15 degrees F. for at least 12 hours. It is then removed and placed in water, where it must remain at least one hour, the temperature of which is at least 150 degrees F. This operation is repeated ten (10) times, after which the sample is again weighed while still wet from the last thawing. Its crushing strength should then be determined as called for in section 6.

9. The Fire test is made as follows: Two samples are placed in a cold furnace in which the temperature is gradually raised to 1700 degrees F. The test piece must be subjected to this temperature for at least 30 minutes. One of the samples is then plunged in cold water (about 50 degrees to 60 degrees F.) and the results noted. The second sample is permitted to cool gradually in air, and the results noted.

10. The following requirements must be met to secure an acceptance of the materials: The Modulus of Rupture for concrete blocks at 28 days old must average one hundred and fifty and must not fall below one hundred in any case. The ultimate compressive strength at 28 days must average one thousand pounds per square inch and must not fall below seven hundred in any case. The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15 per cent and must not exceed 22 per cent in any case. The reduction of compressive strength must not be more than thirty-three and one-third per cent, except that when the lower figure is still above one thousand pounds per square inch, the loss in strength may be neglected. The freezing and thawing process must not cause a loss in weight greater than ten per cent, nor a loss in strength of more than thirty-three and one-third per cent; except that when the lower figure is still above one thousand pounds per square inch, the loss in strength may be neglected. The Fire Test must not cause the material to disintegrate.

General Information.

No other department of the cement industry has so felt the need of standard specifications and uniform instructions as we find in the manufacture of cement blocks.

There is today a large and growing demand for this material, and its general and almost unlimited use is only retarded by

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lack of confidence on the part of architects, builders and resident owners who see only the wretched results that attend the efforts of the misinformed and inexperienced, and overlook the splendid possibilities of this form of construction in the hands of skilled and experienced operators.

In considering the requirements that cement blocks should meet as a structural material, we must take into account the use in which they are to be put.

We have in brick classification, the terra cotta brick, mud brick, and dry pressed face brick, and the hard burned, medium and light common brick; all of which find extensive and legitimate use, and yet vary widely in strength, fireproof qualities and appearance.

The granites, limestones, sandstones and marbles are generally accepted in first-class construction, and yet differ greatly in weather and fire resisting qualities.

Lumber, of course, is very combustible, and yet the different varieties show marked contrast in strength, durability and fire-resisting qualities, and we have to learn of any municipal requirements stipulating the kind of lumber for building construction.

With these facts in mind, is it not fair to ask that some latitude be granted in the manufacture and use of cement blocks?

If an owner in most localities chooses to build the outside walls of his factory or residence of light burned common brick, showing an absorption of 30 per cent water, who is there to say No? In fact, the average so-called hard burned brick will absorb 20 to 22 per cent water and will pass muster under most municipal and architects' requirements; yet our leading municipal specifications require that cement blocks shall not exceed 15 per cent absorption, regardless of the use to which they are put.

Cement blocks may be properly used in substitution of other materials for:

1. Foundations.
2. Exterior and superstructure walls carrying weight.
3. Curtain walls, exterior and interior.
4. Fire walls and partitions.
5. Veneering.
6. Retaining walls.
7. Cornice, trim, and ornamental work.
8. Filler blocks for floor slabs.
9. Chimney flues, etc., etc.

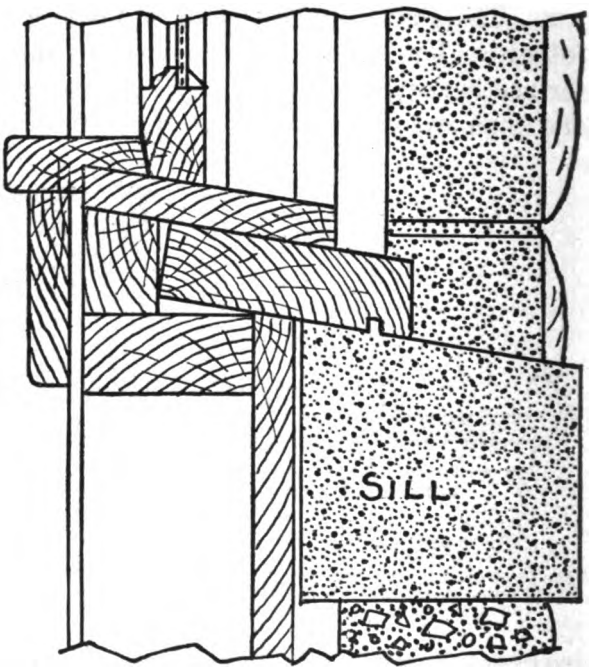

Fig. 24—Section illustrating the method for the construction of the window sill.

In this variety of work it is at once seen that uniform and the highest quality is now required.

Experience in the use of other materials has taught us to recognize, practically without repeated or preliminary tests, the quality of most materials for which cement blocks are substituted, and this fact alone gives them an advantage over the newer material.

Commercial, local and natural causes are, however, calling for the more exten-

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sive use of cement blocks; this demand will increase as our manufacturers of cement blocks gain experience, and by the encouragement and observance of rational building requirements. It is of prime importance to every city and town in this country, having a building code, that they should recognize and include cement blocks as a building material.

The writer of the specifications herewith submitted, Mr. E. S. Larned, C. E., 101 Milk St., Boston, Mass., as Chairman of the Committee on Tests of Cement and Cement Products of the National Association of Cement Users, recommended in his report, last January, that a Specification Committee be appointed by the Association to draw up a standard specification and uniform instructions covering the manufacture of cement blocks, with the hope that this form, when prepared, might be offered to all the cities and leading towns in the United States for adoption.

As a basis upon which to consider the standard specifications and uniform instructions, my suggestions included the following in part:

Cement. Only a true high-grade Portland cement, meeting the requirements and tests of the standard specifications of the American Society for Testing Materials shall be used in the manufacture of cement blocks for building construction.

Unit of Measurement. The barrel of Portland cement shall weigh 380 pounds net, either in barrels or sub-divisions thereof, made up of cloth or paper bags, and a cubic foot of cement packed as received from the manufacturer, shall be called 100 pounds of the equivalent of 3.8 cubic feet per barrel. Cement shall be gauged or measured either in the original package as received from the manufacturer, or may be weighed and so proportioned; but under no circumstances shall it be measured loose in bulk, for the reason that when so measured it increases in volume from 20 to 33 per cent, resulting in a deficiency of cement.

Proportions. Owing to the different values of natural sand or fine crusher screenings for use in mortar mixtures, due not only to its mean effective size, but also to its physical characteristics, it is difficult to do more in a general specification than fix the maximum proportions of good sand that may be added to cement.

Sand, or the fine aggregate, shall be suitable silicious material passing the one-

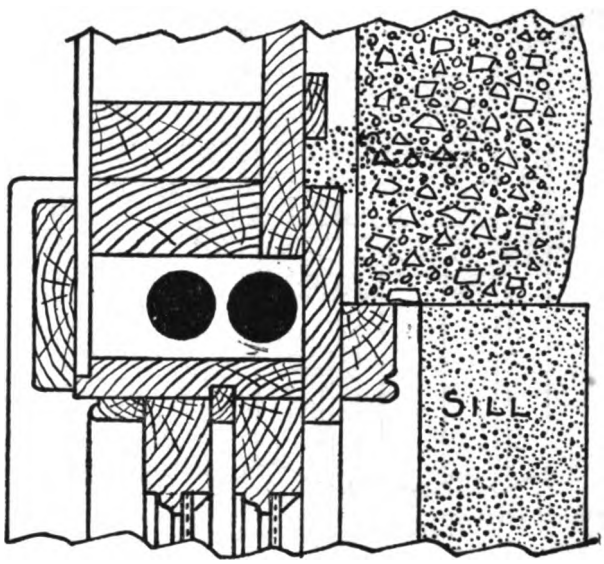

Fig. 26—Section illustrating the window construction, both exterior and interior.

fourth inch mesh sieve, and containing not over ten per cent of clean, unobjectionable material passing the No. 100 sieve. A marked difference will be found in the value of different sands for use in cement mortar. This is influenced by the form, size and relative roughness of the surface of the sand grains, and the impurities, if any, contained.

Only clean, sharp and gritty sand, graduated in size from fine to coarse and free from impurities, can be depended upon for the best results. Soil, earth, clay and fine "dead" sand are injurious to sand, and

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at times extremely dangerous; particularly in dry and semi-wet mortars, and they also materially retard the hardening of the cement. An unknown or doubtful sand should be carefully tested before use to determine its value as a mortar ingredient.

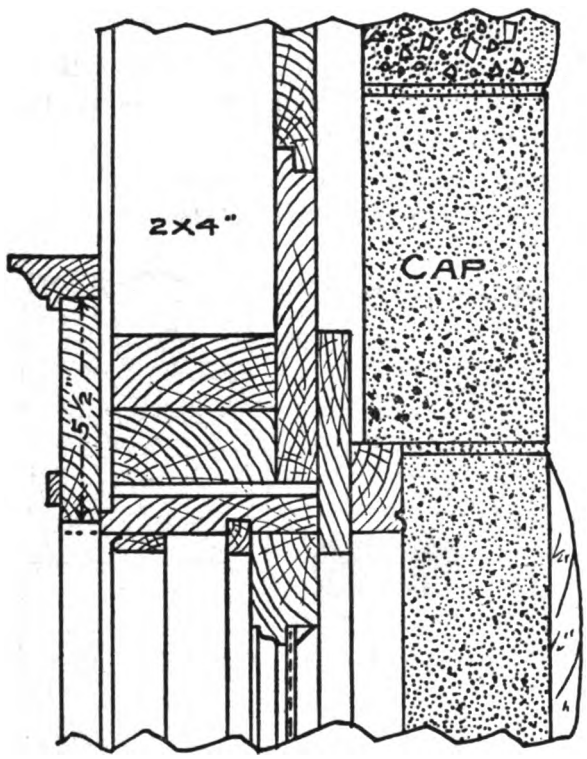

Fig. 23—Sectional view, showing the details of work about the window caps.

Screenings from crushed trap rock, granite, hard limestone and gravel stones are generally better than bank sand, river sand or beach sand in Portland cement mortars (but not so when used with natural cement, unless the very fine material be excluded).

So-called clean but very fine sand has caused much trouble in cement work, and should always be avoided, or if impossible to obtain better, the proportion of cement should be increased. Stone screenings and sharp, coarse sand may be mixed with good results, and this mixture offers some advantages, particularly in making sand-cement blocks.

For foundations or superstructure walls exposed to weather, carrying not over eight tons per square foot, the maximum proportion shall not exceed four parts sand to one part cement. This proportion, however, requires extreme care in mixing for uniform strength and will not produce water-tight blocks. We recommend for general work not over three parts sand, if well graded, to one part cement, and the further addition of from two to four parts of clean gravel stones passing the three-fourths inch sieve and retained on a one-fourth inch mesh sieve, or clean screened broken stone of the same sizes. These proportions, with proper materials and due care in making and curing, will produce blocks capable of offering a resistance to crushing of from 1,500 to 2,500 pounds per square inch at twenty-eight days.

(For the best fireproof qualities limestone screenings or broken sizes should be excluded, but otherwise are all right for use.)

Where greater strength is desired, particularly at short periods, from two to six weeks, we recommend the proportions of one and one-half to three parts gravel or broken stone of sizes above given. Blocks made of cement, sand and stone, are stronger, denser, and consequently more waterproof than if made of cement and sand only, and are more economical in the quantity of cement used.

Mixing. The importance of an intimate and thorough mix cannot be overestimated. The sand and cement should first be perfectly mixed dry and the water added carefully and slowly in proper proportions, and thoroughly worked into and throughout the resultant mortar; the moistened gravel or broken stone may then be added either by spreading same uniformly over the mortar or spreading the mortar uniformly over the stones, and then the whole mass shall be vigorously mixed together until the coarse aggregate is thoroughly incor-

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porated with and distributed throughout the mortar.

We recommend mechanical mixing wherever possible, but believe in the thorough mixing of cement and sand dry before the addition of water; this insures a better distribution of the cement throughout the sand, particularly for mortar used in machine made blocks of a semi-wet consistency. For fine materials, such as used in cement blocks, it is necessary that the mechanical mixer be provided with knives, blades or other contrivances to thoroughly break up the mass, vigorously mix the same and prevent balling or caking.

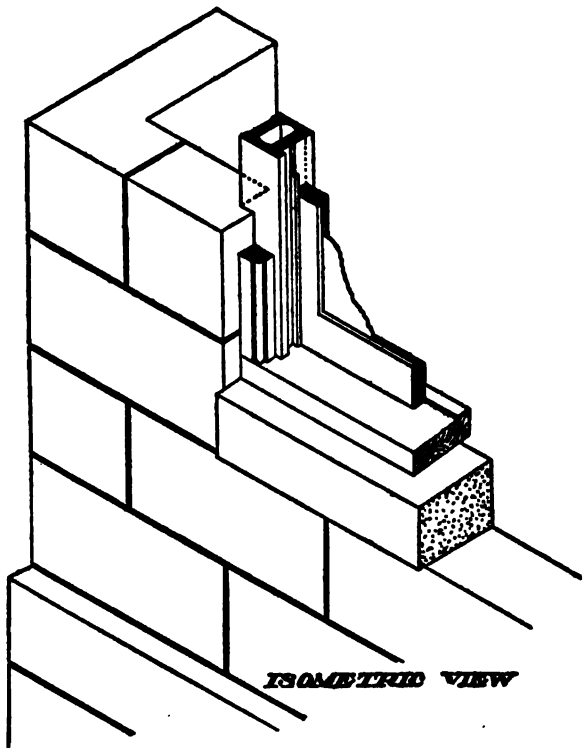

Fig. 11—Method in detail of work of constructing window ledge and frame in connection with blocks.

Curing. This is a most important step in the process of manufacture, second only to the proportioning, mixing and molding, and if not properly done, will result either in great injury to or the complete ruin of the blocks. Blocks shall be kept moist by thorough and frequent sprinkling, or other suitable methods, under cover, protec from dry heat or wind currents for at lea seven days. After removal from the curing shed, they shall be handled with extreme care, and at intervals of one or two days shall be thoroughly wet by hose sprinkling or other convenient methods. We recommend curing in an atmosphere thoroughly impregnated with steam. This method serves to supply needed moisture, prevent evaporation, and is some measure accelerates the hardening of the blocks.

We view with distrust, in the present knowledge of the chemistry of cement, any artificial, patented or mysterious methods of effecting the quick hardening of cement blocks or other cement products. If such method be proposed, it should be thoroughly investigated by competent authority before use.

Time of Curing. This is also most important in its effect upon the industry, and is directly and vitally influenced by the following conditions:

1. Quality, quantity and setting properties of the cement used.
2. Quality, size and quantity of the sand or fine aggregates used.
3. Amount and temperature of water used.
4. Degree of thoroughness with which the mixture is made.
5. Method of curing, weather conditions and temperature.
6. Density of the block as affected by the method and thoroughness of tamping or pressure applied.

Before fixing the minimum permissible time required in curing and aging blocks, it is well to consider the important effect of additions of sand upon the tensile strength of cement mortar.

The following tabulation has been interpolated from the diagram of cement mortar tests prepared by Mr. W. Purves Tay-

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lor, of the Philadelphia Municipal Laboratories.

The results of the neat tests and the 1 to 3 mortar tests (i. e. one part cement to 3 parts crushed quartz by weight) are averaged from over 100,000 tests, while the other results are based on from 300 to 500 tests.

Tensile strength in lbs. per square inch of Portland Cement.

Proportions	7 days.	28 days.	2 mos.	3 mos.	4 mos.	6 mos.	12 mos.
Neat cement	710	768	760	740	732	758	768
1 to 1 mortar	590	692	690	680	680	685	695
1 to 2 mortar	370	458	460	455	453	458	460
1 to 3 mortar	208	300	310	310	310	310	308
1 to 4 mortar	130	210	230	230	230	232	232
1 to 5 mortar	80	150	185	195	195	195	197

It must also be kept in mind that these results are obtained under practically uniform and theoretically correct conditions, in the amount of water used, thoroughness of mixing and molding and storage of samples until tested.

Comparing the results at 28 days, it is apparent that the 1 to 5 mortar has only 71 per cent. of the strength of the 1 to 4 mortar, and but 50 per cent of the strength of a 1 to 3 mortar. The 1 to 4 mortar has but 70 per cent. of the strength of a 1 to 3 mortar and 46 per cent. of the strength of a 1 to 2 mortar.

The ratio of compressive strength to tensile strength is not quite constant for all periods of time, and for the several mixtures above given; but the compressive strength, or resistance to crushing per square inch, may be approximately ob-

Fig. 7—This illustration shows the arrangement of concrete blocks in connection with a concrete porch and steps.

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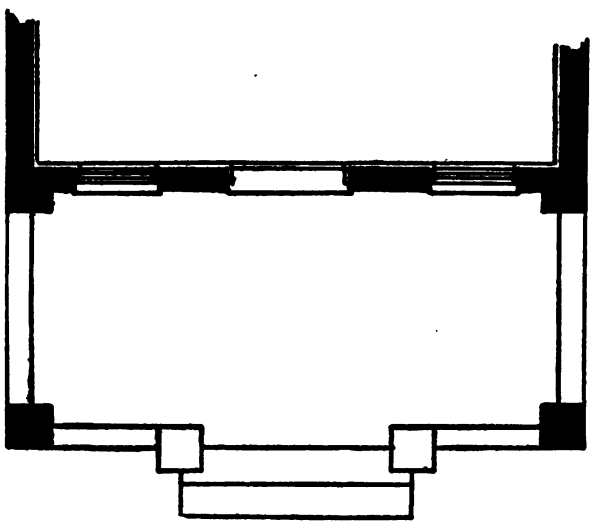
tained by multiplying the tensile strength given in the above table by the constant six (6). (Note. This would increase with the age of the mortar, and would be greater for good gravel or stone concrete than for the clear mortar of which a given concrete is made.)

In fixing the minimum time required for curing and aging blocks before use, due regard should be given to the proportions used. It is manifestly wrong in principle to require as long a period for a 1 to 2 or a 1 to 3 block as might seem necessary for a 1 to 4 or a 1 to 5 block, and it is obviously unsafe to attempt to use a block of lean



PLAN OF CEMENT PORCH

proportions in as short a time as a rich mixture would gain the necessary strength.

This might be supposed to be met by fixing the minimum resistance to crushing of blocks (of all compositions); but it must be kept in mind that a very small percentage of the blocks used are tested, by reason of the expense, inconvenience, or lack of facilities.

The required minimum resistance to crushing of first-class blocks used for exterior and bearing walls should not be imposed upon blocks for minor and less important uses.

Marking. All cement blocks should be stamped (in process of making), showing name of manufacturer, date (day, month and year) made, and composition or proportions used. The place of manufacture, methods and materials should also be open to inspection by representatives of the Building Departmest, the Architect, Engineer or individual buyer.

Establishing a Block Plant.

Location of Plant. The first thing to take under consideration is the proximity to the raw material, both sand and rough stone or granite. This point should be well looked into before a location is decided upon. It is necessary to have good roads from the plant at all seasons of the year in order to facilitate delivery of product and receive materials. The place where the plant is located should be level, and of sufficient space to provide for yard room and the laying of tracks, especially if a large stock of blocks is to be carried. After these points have been determined, the subject of the buildings may be considered.

Building. A block maker cannot give a better advertisement for his wares than to operate in a building made of his own blocks. There should be ample floor space and the floors should be of concrete. All the machinery should stand on concrete foundations.

Equipment. A practical equipment should be sufficient number of machines to give an average minimum capacity of 400 standard size blocks, for the investment calls for this number of blocks daily to make the earning commensurate. There should be a mixer suitable to handle the dry and semi-dry material, having a capacity at least fifty per cent in excess of the

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initial requirements, thus permitting the installation of additional block machines without any change in the capacity of the mixer. A crusher and rolls, together with a set of revolving screens also should be installed to properly screen and crush the aggregates necessary to acceptable concrete work. A system of storage bins for cement also must be provided. The number of cars should be sufficient to hold at least two days output of the plant. There should be an engine and boiler of sufficient horse power to run the machinery and afford steam heat in cold weather.

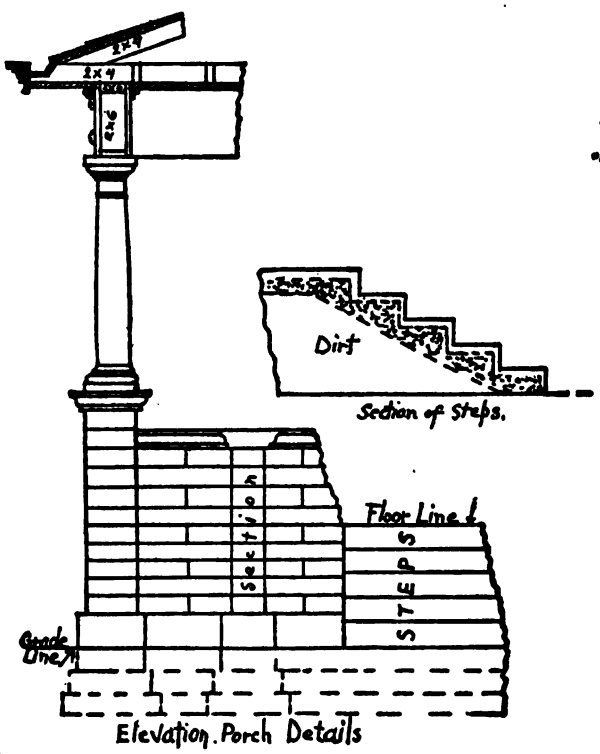

Fig. 12—Details of concrete block porch, concrete pillars and steps. Note the method of joining the roof to the pillars.

Accessories. In addition to the manufacture of blocks, it is becoming necessary for many concerns to undertake the making of sills, lintels, columns, caps, etc. This is work that the standard block machines do not perform. Special molds are required for this work of the size of the article that it is desired to produce. The lumber for this work should be carefully selected, sandpapered and shellacked. Columns, balusters and caps can be cast in sand or in the manner described for the casting of ornamental figures, or better still, special machinery for these purposes should be installed. There are certain standard sizes in much of this work, and, as a rule, it would be well to keep an exhibit on view to give builders ideas as to special adornments for concrete block houses. Attention to the accessories and miscellaneous articles will assure a diversity of product and an increased business.

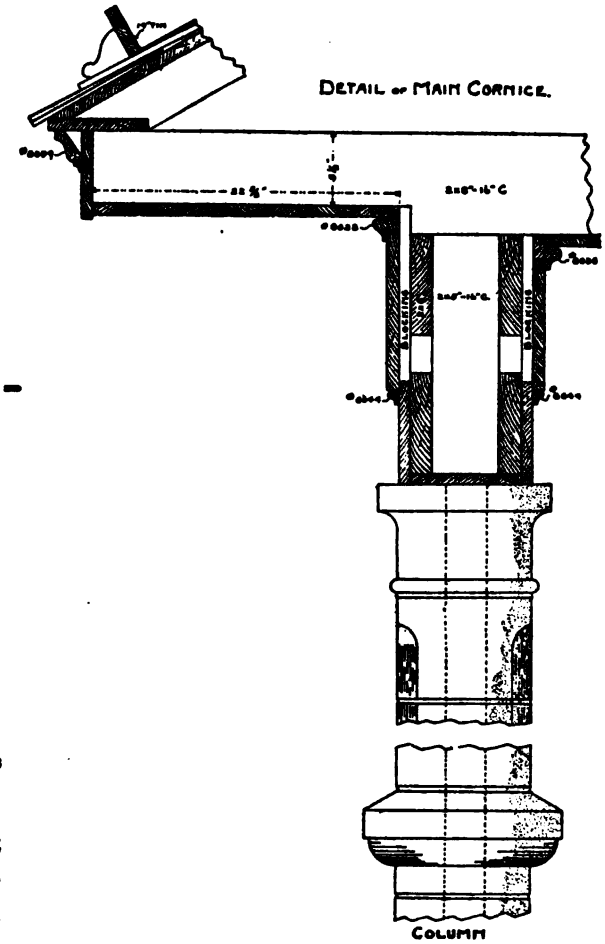

Fig. 30—Details of constructing porch pillars in conjunction with frame cornice.

Importance of Labor. It has grown to be a notion in many quarters that most any kind of labor is good enough for a block

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plant. The most ignorant numbskull is thought efficient in the handling of materials that are to enter into the concrete. Herein lies the most pernicious error. The cement handler should be a man of good sense, a mechanic, a chemist, a man who can comprehend the importance of exactness in mixing proportions.

Patterns. Every plant should have an employe who is capable of making patterns to suit any special size or design of block that may be required to suit an architect's plans. It is the thoroughly equipped factory that aims to meet the demands of the building public that will succeed.

Concrete Block Systems.

There are two systems of block making. They differ in the consistency of the concrete used. They are:

1. Blocks tamped or pressed from semi-wet concrete and removed from the mold.

2. Blocks poured or tamped from wet concrete and allowed to remain in the mold till hardened. Most of the blocks on the market are made by the semi-wet method in machines, from which the cores are removed and the side plates taken away as soon as the block is formed. Then the block is lifted from the machine. The most popular machines have adopted the standard length of 16 and 24 inches, a height of 9 inches and a thickness of 8, 10 and 12 inches.

The various styles of blocks are rock faced, the most popular, plain, tool faced, paneled, grooved, ashlar and imitation cobble stone.

Block Machines. They may be divided into two classes, although they are all of the same general type and differ only in their methods of operation. There are two types, those having a vertical and those having a horizontal face. In the vertical machine the face stands vertically and the block is lifted from the machine on its base plate as soon as tamped. In the other machine the face plate forms the bottom of the mold. The cores are withdrawn horizontally and the block with its face plate is tipped up into a vertical position for removal.

In the use of the horizontal face machine it is an easy matter after the face is tamped and the cores are pushed into place to throw into each opening a small amount of rich and rather wet mortar, spreading it evenly, and then go on tamping in the ordinary mixture until the mold is filled. In this manner a dense layer across each of the cross walls is obtained, which effectually prevents moisture from passing beyond it.

Mixing. The strength of a block is equal only to that of its weakest part. The object to be aimed at is to have all parts of the block of uniform strength. This can be attained only by thorough mixing. The poor blocks turned out are more often due to this fault than to a shortage of cement. It should be borne in mind that the materials must be mixed dry until the cement is uniformly distributed and perfectly mingled with the gravel and sand. Then the water may be added and the mixing continued until all parts are equally moist and every grain of sand coated with cement.

Concrete Mixers. Without any doubt the machine is preferable to hand work. Hand mixing is always imperfect, laborious and slow. Even if the amount of business is small, the machine will be found more satisfactory in the end, and if any quantity of work is to be done, it is absolutely necessary as a labor saver and effective agent in bringing about success. For general purposes, batch mixers that take a measured quantity of material and mix it are the only kind to use.

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Facing. This is made usually of cement and sand or fine screenings that pass a 1-8 inch sieve. At least as rich a facing as 1 to 3 is necessary to get the same hardness and strength as a 1 to 5 gravel mixture. The facing often is given the block of this finer mixture to give a smoother finish, making the body of the block poorer and of coarser material. The advantage of this practice is in many cases questioned by architects. To be successful in making blocks, make them honest. There is profit in doing honest work. There is satisfaction in it. The industry can suffer no greater injury than from skimpy or dishonest products.

Caps and Sills. Good machines are on the market for the manufacture of these staples in building. In every case, if the sill of the cap is to exceed three feet in length, a reinforcement should be provided. This should be placed about one inch from the bottom surface. Caps up to three feet, as a rule, may be said to be strong enough to stand the ordinary stress they are called upon to carry. Beyond that length, it will be the part of wisdom to guard against weakness.

Stonettes. In many localities there are deposits of natural stone of a prevailing or uniform color that lend themselves readily to the making of imitation stone by the use of cement. In making this product, it is necessary to use cement that has been thoroughly air slacked and finely sifted. The proportions are 2 of cement and 7 of aggregate. The aggregates should be crushed fine. It is well to use a little oxide to counteract the color of the cement and permit the color of the aggregates to prevail. This mixture can be used in castings for ornamental work in the same manner as in making imitation marble.

Proportions.

Under this head, in the making of hollow concrete blocks, three things are to be considered: Strength, permeability and cost. The blocks that are porous and absorb moisture are those in which the proportions of cement are 1 to 8 or 1 to 10. Still they have a strength to carry a load of any weight. Blocks made of cement and sand, 1 to 3, are not as strong or so impermeable to water as those made of good mixed sand and gravel, 1 to 5. It is the general opinion that satisfactory blocks cannot be made by the hand method of mixing and tamping from a poorer mixture than 1 to 5. Even at this there must be a grading of the gravel, liberal use of water and thorough mixing and tamping. Very fine sand is bad, and good blocks cannot be made from it, except by the use of an amount of cement that would make the cost ruinous. By properly grading the gravel to reduce the voids, the water resisting qualities of the block will be improved without loss of block will be improved without loss of strength, and that is desirable. A part of the cement for this purpose may be replaced by a small amount of hydrated lime. The following mixtures then are recommended :

1 to 4 mixtures by weight.
Cement 150, gravel 600.
Cement 125, Hyd. lime 25, gravel 600.
Cement 100, Hyd. lime 50, gravel 600.
1 to 5 mixtures by weight.
Cement 120, gravel 600.
Cement 100, Hyd. lime 20, gravel 600.

Or if it is preferred a good water-proofing compound may be employed instead of the hydrated lime, in which case the proportions will be changed in accordance with instructions sent out by the manufacturers.

Concrete Aggregate.

These are the materials that are bound together by the matrix or cement: Granite, stones, marble, gravel, sand, shells, slate, metal filings, etc., comprise the natural

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aggregates. Aggregates should be clean and angular. Any foreign substance on the material prevents the cement from coming into contact with the surface and weakens the composition to that extent. Coarse aggregates are cleaned easily by spreading the material on an inclined plane and turning a hose on the pile, allowing the water to carry away the impurities. Every user of cement knows that the use of clean aggregates increases the tensile strength of the composition 15 to 20 per cent.

Water-Tight Concrete. Study of the subject of aggregates recently has demonstrated the fact that a mixture of one part cement, three parts of sand and seven of aggregates makes nearly a water tight concrete. This has been proved by many makers of concrete. Ordinarily speaking, a mixture of one part cement, two of sand and four of aggregates is almost water tight when it is carefully made.

Porous Aggregates. Unless porous aggregates are well soaked in water before coming into contact with the cement, they will absorb the water used in gauging. With the aggregates well filled with water, the cement will have an opportunity to adhere to the particles. It should be borne in mind that the office of water has nothing to do with the adhesiveness of the cement. Its only purpose is to make the mass plastic.

Fire Proof Aggregates. Slag is one of the best. Granite, stone and flints crack when subjected to great heat. Coke breeze concrete, when subjected to great heat, will gradually crack and fall to dust. Slag is one of the best, because it is material that already has been subjected to great heat and is rendered one of the best substances on that account. Its angularity and density and cheapness are all in its favor. In the selection of slag, care should be taken to avoid any that has sulphur in it, as that chemical is detrimental to Portland cement. Other substances that are considered fire proof are fire bricks, pottery, hard clinkers and pumice stone, all of which have been through the fire.

Voids in Aggregates. The voids are the depressions or the interstices on the surface and the quantity depends upon the shape and size. In the aggregates that are broken small, the quantity will be smallest. It has been the custom often to mix sand with the gravel or stones to fill the voids and thus secure the full strength of the concrete without using more cement than provided by the proper ratio. A simple method for ascertaining the amount of voids is as follows: Take a receptacle of known capacity and fill it with the aggregates, shaking them well down. Then pour in water till the receptacle is brim full. The amount of the voids will be equal to the measure of the water which can be poured off.

Percentage of Voids. The following table gives the per cent of voids and weight per cubic foot of some common concrete materials:

	Voids.	Weight per cu. ft.
Sandusky Bay Sand	32.3	111.7
Same through 20-mesh screen	38.5	101.5
Gravel, ¼ to ⅛ inch	42.4	95.0
Broken limestone, egg size	47.9	87.4
Limestone screening, dust to ½-inch	26.0	122.2

A series of experiments made in Germany by R. Dykerhoff, shows the gain in strength obtained by adding coarse material to mixtures of cement and sand. The blocks tested were 2½-inch cubes, one day in the air and 27 days in water. The table is as follows:

—Proportions by measure.—			Pct. cement.	Compression strength
Cement.	Sand.	Gravel.	by volume.	lbs. per sq. in.
1	2	..	33	2.125
1	2	5	12.5	2.387
1	3	..	25	1.383
1	3	6½	9.5	1.515
1	4	..	20	1.053
1	4	8½	7.4	1.204

These figures give an idea of how greatly

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the strength is improved by adding coarse material, even though the proportion of cement is thereby reduced. From this is to be learned the lesson that in choosing the materials for concrete, those should be chosen that give the greatest density. It is easy to experiment with sand and gravel to ascertain what proportion gives the greatest density, and then this proportion should be adhered to rigidly. Well proportioned dry sand and broken stone well shaken down should weigh at least 125 pounds per cubic foot. On the other hand, limestone screenings are lighter on account of the small pores in the limestone. They should weigh at least 120 pounds per cubic foot. If the weight is less, there is probably too much fine dust in the mixture.

Sand.

Clean Sand. It is easy to determine whether sand is clean. Sand should not be used if it soils the hands when rubbed between them. Another method of determining whether the sand is clean is to drop a quantity into a pail of clear water. If the water in two minutes is clear enough to enable you to see the sand at the bottom, the sand is clean. Still another method is to put some of the sand into a fruit jar with some water, shake well and let the jar stand till all the materials have settled. If a layer of mud is seen over the sand, the sand is not clean and should not be used.

Allowance for Voids. A common error in estimating the quantity of concrete a given quantity of material will make results from not allowing for the voids in the aggregate. Thus six barrels of broken stone, three barrels of sand and one barrel of cement will not make ten barrels of concrete. The cement fills the voids between the grains of sand and the sand fills the voids of the stone. The amount of concrete will be only slightly in excess of the amount of bulk of the stone.

Different Mixtures. For ordinary purposes to which it is put, concrete mixtures may be described as rich, medium and ordinary.

Rich Mixture. This is used in reinforced foundations for machinery for reinforced floors, beams and columns and for tanks and work that is water-tight. The proportions are one part cement, two parts sand and four parts gravel or crushed stone.

Medium Mixture. For thin foundation walls, arches, ordinary floors, sidewalks, sewers, etc. The proportions are one part cement, two and one-half parts sand, and five parts gravel or crushed stone.

Ordinary Mixture. This mixture is used in heavy walls, piers and abutments that are to be subjected to considerable strain. The proportions are one part cement, three parts sand and six parts gravel or crushed stone.

Lean Mixture. A mixture of one part cement, four parts sand and eight parts gravel or crushed stone, may be used for work in which the mass is to be subjected only to compression, like subfoundations or backing for stone masonry.

Test for Sand. The purpose of testing is to determine which of two or more sands will produce the denser, and therefore the stronger mortar in any given proportions. The following method is suggested as a means for determining this point:

If the proportions of the cement to sand are by volume, they must be reduced to weight proportions; for example, if a sand weighs 83 pounds per cubic foot moist, and the moisture found by drying a small sample of it at 212 degrees Fahrenheit is 4 per cent, which corresponds to about 3 pounds in the cubic foot, the weight of the dry sand in the cubic foot will be 83-3, which is 80.

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If the proportions by volume are 1:3, that is, one cubic foot of dry cement to three cubic feet of moist sand, and if we assume the weight of the cement as 100 pounds per cubic foot, the proportions by weight will be 100 pounds of cement to 3 times 80, which is 240 pounds of sand, which corresponds to 1:2 by weight.

Test for Strength. A convenient measure for the mortar is a glass graduate, about one and one-half inches in diameter, graduated to 250 cubic centimeters. A convenient weight of cement plus sand for a test is 350 grams. The sand is dried and mixed with cement in the calculated proportions, in a shallow pan about ten inches in diameter and one inch deep. The mixing is done conveniently with a 4-inch pointing trowel. The dry, mixed material is formed into a circle as in mixing cement for briquets, and sufficient water added to make mortar of plastic consistency, similar to that used in laying brick masonry. After mixing about five minutes, the mortar is introduced about 20 cubic centimeters at a time into the graduate, and, to expel any air bubbles, it is lightly tamped with a stick having a blunt end. The mortar is allowed to settle in the graduate for one or two hours, until the level becomes constant, when the surplus water is poured off, and the volume of the mortar in cubic centimeters is read.

The other sands that are to be compared with this are then prepared in the same way. After testing all the mortars, the sand which produces the strongest mortar is immediately located as that in the mortar of lowest volume.

Sand and Tensile Strength. The effect of different aggregates on the strength of cement mortar and concrete is a subject that ought to be studied by the operator at the outset, for herein lies the important factor of permanency. The subject was explained by Sanford E. Thompson in a paper read at a convention of the National Cement Users' Association. Tests by Rene Feret of France with mortar made from different natural sands show a surprising variation in strength, which is evidently due simply to the fineness of the sand, of which the different specimens are composed.

Selecting from his results proportions 1:2:5 by weight (1 of cement, 2 of sand and 5 of aggregate) and converting his results at the age of five months from French units to pounds per square inch, the average tensile strength of Portland cement mortar made with coarse sand is 421 pounds per square inch, and with fine sand, 302 pounds per square inch, a difference of 119 pounds per square inch, in favor of the coarse sand. The tensile strength found by the use of medium sand was 368 pounds per square inch. In the crushing strength, usually the most important consideration, the difference is even more marked. In round numbers, at the age of five months the mortar of coarse sand gave 5,200 pounds per square inch; the medium, 3,400, and the fine sand, 1,900 per square inch. Note that the different sands were not specially prepared, but were taken out of the bank for the tests just as sand is used every day in concrete work.

Principles for Selecting Sand. The only characteristics of sand which may be considered are the coarseness and relative coarseness of its grains and its cleanliness. These qualities affect the density of the mortar produced; and therefore, the test of the volume of mortar or "yield," determines which of two or more sands is best graded.

The best sand is that which produces the smallest volume of plastic mortar when mixed with cement in the required propor-

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tions by weight. A high weight of sand and a corresponding low per cent of voids are indications of coarseness and good grading of particles. But because of the impossibility of establishing uniformity in weighing or measuring, they are merely general guides which cannot under any conditions be taken as positive indications of true relative values.

Standard Sand. The Committee on Standard Specifications for Cement of the American Society of Civil Engineers in its report recommends the natural sand from Ottawa, Ill., screened to pass a sieve having twenty meshes per lineal inch and retained on a sieve, having 30 meshes per lineal inch. The committee says that sand having passed the No. 20 sieve shall be considered standard when not more than one per cent passes a No. 30 sieve after one minute of continuous sifting of a 500 gram sample.

Weight of Sand. A heavy sand is generally denser and therefore better than light sand. However, this is not a positive sign of worth, because the difference in moisture may affect the weight by twenty per cent, and when weighed dry the results are not comparable for mortars, since a fine sand takes more water than coarse.

Coarseness of Sand. A coarse sand produces the densest and therefore the strongest mortar or concrete. A sufficient quantity of fine grains is valuable to grade down and reduce the size of the voids, but in ordinary natural material, either sand or screenings, there will be found sufficient natural material for ordinary proportions. A dirty sand, one containing fine clay or other mineral matter up to 10 per cent, has been found by actual tests to be better than clean sand for lean mortars; that is, mortars of one to four or one to five. For water tight work it is probable that a larger proportion of very fine grains may be employed than for the best results in strength. Feret's rule for sand to produce the densest mortar is to proportion the coarse grains as double the fine, including the cement, with no grains of intermediate size. There is difficulty in an exact application of this rule, but it indicates the trend to be followed in seeking maximum density and strength.

Cleanness of Sand. An excess of fine material or dirt, as has been noted, weakens a mortar that is rich in cement. It may also seriously retard its setting.

Sand vs. Broken Stone Screenings. Many comparative tests of sand and screenings have been made with contrary results. While frequently crusher screenings produce stronger mortar than ordinary sand, it has been found by extensive tests that the reverse is true. This disagreement is due probably to the grading of the particles, although in certain cases the screenings may add to the strength because of hydraulicity of the dust when mixed with cement.

Stone and Gravel.

Values of Different Stones. Different stones of the same class vary so widely that it is impossible to give any hard and fast rule as to their exact comparative values when used in concrete. A comparison by tests with a large number of different kinds of stone indicates that the value of a broken stone for concrete is governed largely by the actual strength of the stone itself, the hardest stone producing the strongest concrete. Comparative tests indicate that different stones in the order of their value in concrete are approximately as follows: 1, trap; 2, granite; 3, gravel; 4, marble; 5, limestone; 6, slag; 7, sandstone; 8, slate; 9, shale; 10, cinders. Another difficulty in the way of an accurate comparison is the variation in the ages of stone of the same classes. The value or

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sandstone is not more than three-fourths of the value of trap and the value of slate is less than half that of trap. Good cinders nearly equal slate and shale in strength.

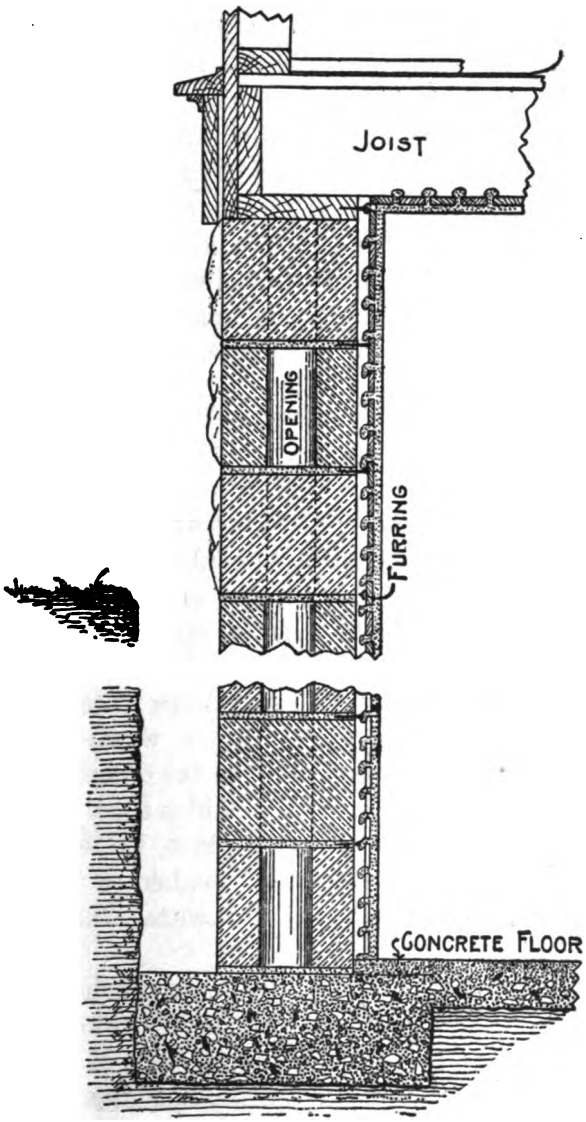

Fig. 28—General details of construction from foundation to the first floor level.

Selection of Stone. The quality of the concrete is affected by the hardness of the stone. In all cases porous stone like sandstone should be avoided. The shape and size also have their influence. If broken stone is used the best is that which is hard; with cubical fracture; with particles whose maximum size is as large as can be handled in the work; with the particles smaller than, say, ¼ inch screened out, and with the sizes of the remaining coarse stone varying from small to large, the coarsest predominating.

Hardness of Stone. The hardness of the stone grows in importance with the age of the concrete. Thus gravel concrete, because of the rounded surfaces, at the age of one month may be comparatively weaker than concrete made with comparatively soft stone, but in a year it may surpass in strength the concrete made with broken stone, because as the cement becomes hard there is greater tendency for the stones themselves to shear through, and the hardness of the gravel stones thus comes into play. Gravel makes a dense mixture, and if much cheaper than broken stone, usually can be substituted for it. A flat grained material packs less closely and generally is inferior to stone of cubical fracture.

Stone and Gravel Compared. The claim is made theoretically that crushed stone is superior to gravel, but the fact remains that gravel is used fully as extensively and with good results. It would appear naturally that crushed stone, on account of its angular shape, would have a better binding quality after tamping than gravel which is smooth and rounded. Still gravel concrete has many supporters, principally because it is more often cheaper and more easy of access than crushed stone.

Screening the Gravel. It is a little more trouble, but almost always best, to screen out the sand from the gravel, or the fine material from the crusher stone, and then remix it in the proportions required by the specifications, for otherwise, the proportions will vary at different points, and one must pay for an excess of cement to balance the lack of uniformity. If gravel is used it is absolutely essential that it shall

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be clean, because if clay or loam adheres to the particles the adhesion of the cement will be destroyed or weakened. Tests of the Boston Transit commission give an

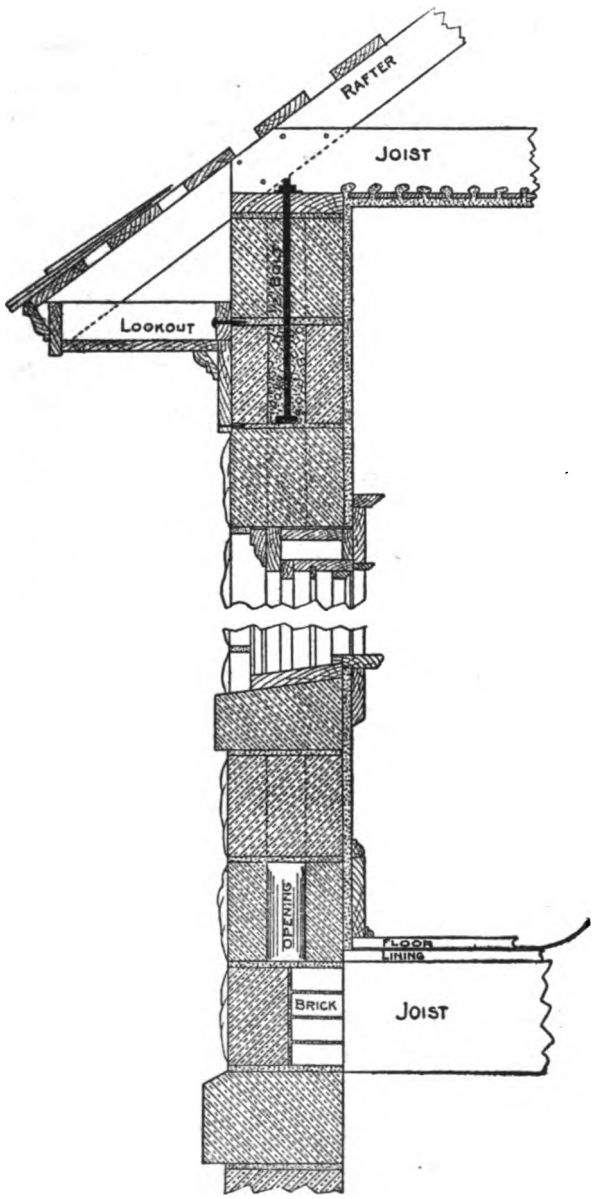

Fig. 27—General details showing the work at the cornice and the bolt method of construction.

average unit transverse strength of 606 pounds per square inch for concrete made with clean gravel, as against 446 pounds per square inch when made with dirty gravel.

Best Sizes to Use. In the case of both stone and gravel the coarsest should predominate, because they increase the strength of the concrete and a leaner mixture can be used than with small stone. In mass concrete the stones, if too large, are liable to separate from the mortar unless placed by hand or derrick as in rubble concrete, and a practical maximum size is 2½ or 3 inches. In thin walls, floors and other reinforced construction, a 1-inch maximum size is generally as large as can be easily worked between the steel. In some cases where the walls are very thin, 3 or 4 inches, a ¾ inch maximum size is more convenient to handle.

Water.

Cleanliness. The first word to be urged under this section is "cleanliness." Nothing but pure, clean water should be used, water that is free from all organic and inorganic impurities.

Fresh cement requires more water than cement that is stale. Often warm water is used in cold weather, but the danger here arises of having small globules form which, when evaporation takes place, leave small holes in the mass that weaken it. It is better to have too little water than too much.

Amount of Water. Use as much water as possible without causing the blocks to stick to the plates or to sag out of shape on being removed from the machine. This is the general rule laid down and it is one of the most important features of block making. Blocks made from material that is too dry are soft and weak. On the other hand, if too much water is used the material will stick to the plates. It will be well before beginning to learn the proper amount by experimentation and then preserve the same measure for each block.

Injury by too Little Water. The in-

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jurious effects of using too little water are shown in the following table prepared after a series of tests, the proportions of the mortar being one part cement and two of sand:

TENSILE STRENGTH—POUNDS PER SQUARE INCH.

Water—Pct. ...8%	12%	14%	16%	18%	20%
Time of test—					
7 days 261	433	392	368	338	301
28 days 344	470	447	436	422	407
3 months 344	490	494	491	457	454
6 months 392	543	536	497	472	430
12 months 300	463	478	434	446	474

How to Overcome Concrete Troubles.

Crazing, or Hair Cracks. These are some of the common disfigurements of artificial stone that are contended with and have not received the attention they should from makers of blocks. Hair cracks, being on the surface, are no indication of a weakness of the block. It has been known for some time that very wet concrete is more apt to craze than dry concrete is. Dry concrete is objectionable to some on

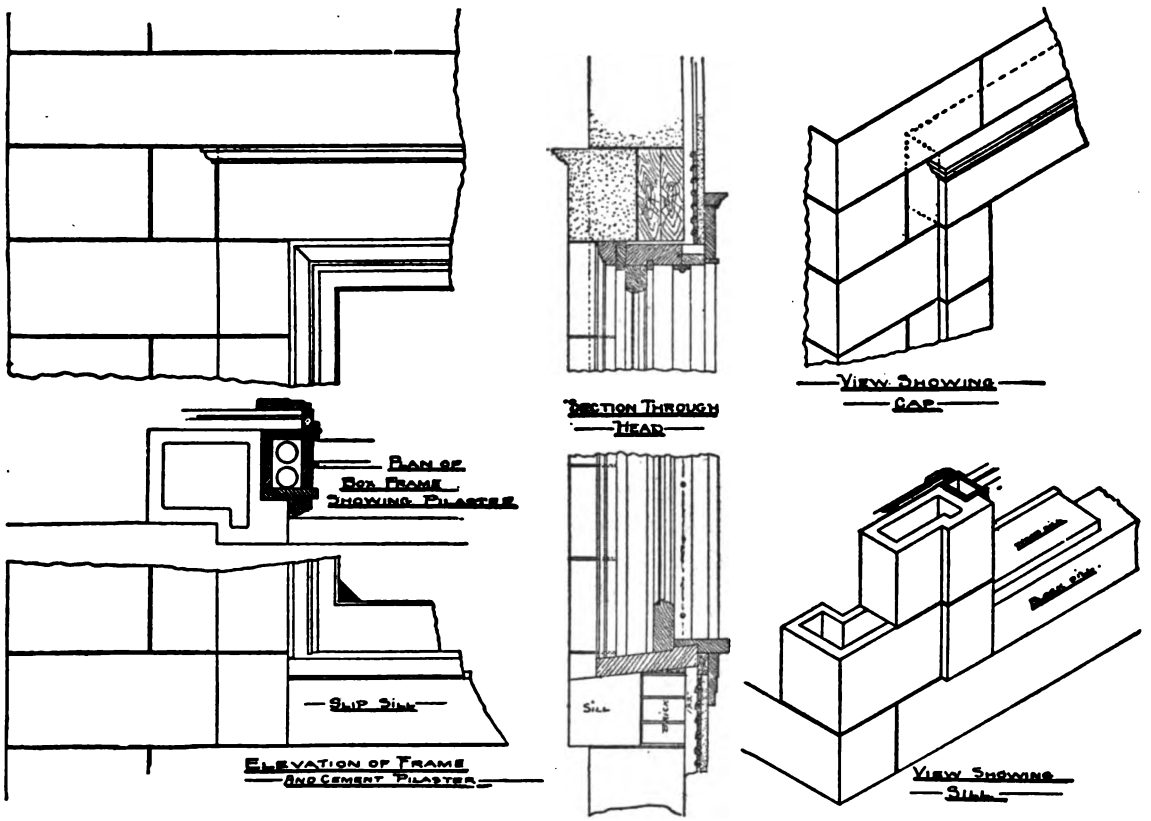

Fig. 10—Here are shown the essential details of wood work around the window frames in connection with concrete blocks.

Immersing Concrete Blocks. Cement, while setting, is injured by sudden changes, in dampness, temperature or air drafts. Therefore, to dip a newly made block into water is injurious. Mix the concrete and sprinkle the water on the dry composition, and keep sprinkling for six or eight days after molding, being careful to avoid all sudden changes.

the claim that it is lacking in strength and density, and on that account its use is not advocated because hair cracks are to some extent avoided. Investigation leaves no doubt of the fact that in wet concrete a portion of the very finest particles of cement is carried to the surface by the action of the excess water which is being absorbed by the atmosphere. This excess

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water is to a large extent drawn from the interior of the concrete to the exterior, carrying with it the finer particles, which, being deposited on the surface, form a richer mortar than is contained in the interior. Under certain conditions these finer particles on the surface practically form a coating of neat cement. Neat cements and richer mortars are found to be much more liable to crazing than mortars containing a larger proportion of sand or finely crushed stone. The cracks are due entirely to a contraction of the surface and not to any contraction of the interior. If the blocks are protected in a moist atmosphere and afterwards immersed in water for twenty-eight days no cracks will appear.

Expansion and Contraction. Experiments conducted by Prof. Swain and Prof. Bauschinger demonstrate that neat cement, when set and hardened in air will contract. This applies to all high-grade Portland cements. On the other hand, experiments show that neat cement hardened under water expands. It may be concluded that in a rich mortar there is more neat cement on the face and that, therefore, there is a greater contraction on the surface.

Efflorescence on Concrete. Efflorescence gathers on stone, brick or terra cotta, and, commonly speaking, it resembles mildew. It is caused by the lime in the cement or mortar coming in contact with water (moisture), sunlight or heat. It is found on natural stone, but more often on concrete blocks. No one formula will remove it in every instance, but a wash of muriatic acid solution (one part acid to forty parts of water) often will remove it. A steel brush also may be used. Efflorescence can be prevented by water-proofing the exterior surface of the wall after the mortar has hardened.

Endurance. A "volume constant" or "sound" cement must be used in the manufacture of blocks to secure a product that will withstand time wear and the gases of the atmosphere. What causes certain cements to swell and expand after being mixed with water is not known definitely. The cause is generally attributed to lack of proportioning of the elements in the making of the cement. Certain brands of cement are much more liable to possess this fault than others, and it is probably due in some cases to insufficient grinding or lack of supervision.

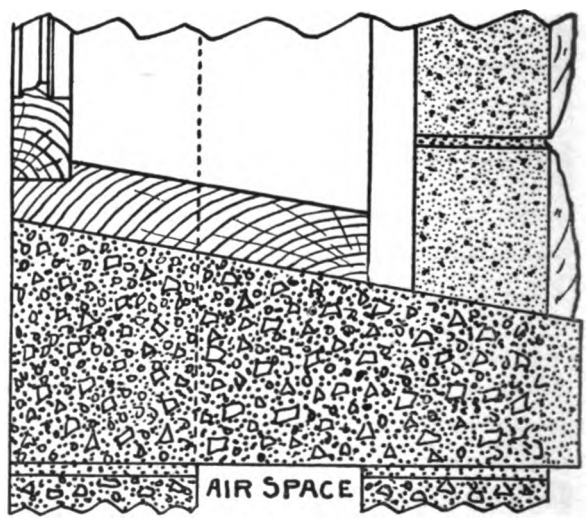

Fig. 21—Top of cellar wall at the junction with cellar windows. Detail shows method of construction.

Curing Stone by Steam.

The blocks, all made by the dry tamp process, are placed in a room whose walls are air tight and the room is opened only to admit additional blocks or for the sprinkling six to eight times a day. The second day, without opening the room, the steam is turned on and continued for forty-eight hours. Then the blocks are removed to the yard and kept damp by spraying two days longer, when they are ready for use.

Tunnel Steaming Process. Another plan is to take the blocks from the molding machine and place them in the shade

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for twenty-four hours, spraying them frequently. Then they are removed from the pallets and placed in a tunnel built with hollow blocks and plastered on the interior with Portland cement and sand. The tunnel is closed and the steam is turned on, being applied for forty to fifty hours, after which the blocks are ready for use. Blocks thus hardened have a metallic ring when tapped with a hammer. The closest investigation fails to show that blocks hardened in this way suffer any injury, proving that cement that has passed the stage of its initial set cannot be injured by heat.

Blocks must be kept damp from the time they are made up till the steam is applied and all blocks must not be less than twenty-four or more than forty-eight hours old when steam is applied. The cement used should be a high burned quality free from lime.

Color of Concrete Blocks.

Outside of all considerations of form and effect the matter of color is not the least important of the product's properties. It is upon this more than anything else that the marketing of the block depends. It is, therefore, important to secure uniformity of color and an effect that will be pleasing to the eye. This requires constant study to attain in its perfection and is one of the greatest problems of the business. For colored blocks dark colored cements may be used to the best advantage, but their color should be uniform. For lighter blocks cement of lighter color must be used. Cement gets lighter as it is ground finer and only finely ground cement should be employed for this work. Cements that were free of manganese and iron would be white and the color grows dark as the percentage of iron and manganese increases, but most cements have more iron than manganese and the color. therefore, is due to the iron.

Sulphate of lime, which always is added to cement to regulate the set, is responsible for the white efflorescence of blocks. The salt is soluble and is carried to the surface of the blocks during the curing process.

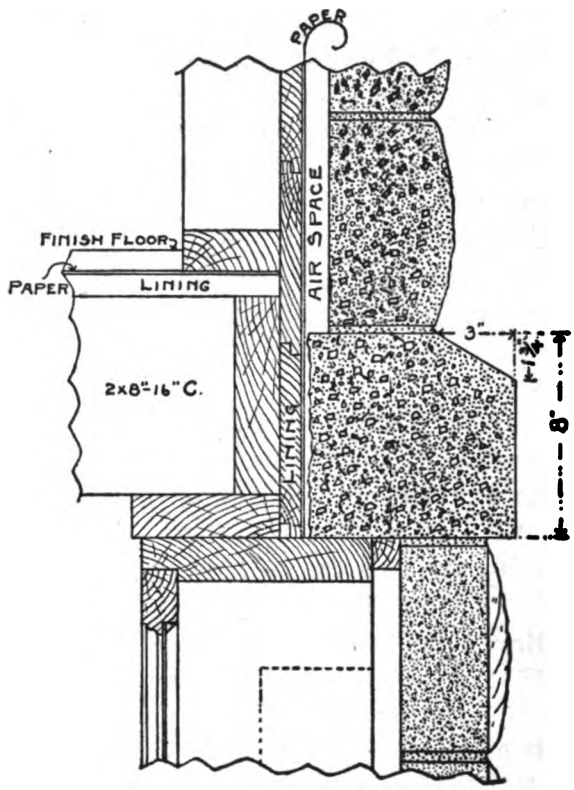

Fig. 25—Section showing the details of construction at the level of the water table, or first floor level.

In coloring artificial stone to a gray the use of one pound of Germantown lampblack mixed with cement dry, and one pound of salt previously dissolved to every ten gallons of water greatly assists to waterproof the product, but does not make an absolutely waterproof stone, although increasing the lampblack makes the stone less absorbent, but it will darken the color and affect the durability.

Black stone is produced by adding peroxide of manganese to the cement at a proportion of twelve to fifty pounds per barrel of cement. The amount is governed

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by the color of the sand and cement or by adding from two to four pounds of excelsior carbon black to each barrel of cement. The manganese in a measure prevents the absorption of water, but the excelsior carbon does not; the first reduces the strength and the other has little or no effect upon the durability or strength of the product.

Blue. The use of any waterproofing in making black stone will discolor the surface. In producing waterproof blue stone the best results are obtained by using five pounds of ultramarine blue, one pound of pulverized alum and one pound of soda mixed dry with the cement. This produces a very sound product less subject to moisture than perhaps any natural product.

Red artificial stone, made either of oxide of iron or Pompeiian red, will not mix well with any waterproofing compound, and it is the opinion that reduction of the absorbing qualities can be done only after the colored product has hardened.

Brown or Buff. In making brown or buff stone, ochre, which in a measure prevents moisture, is employed, but ochre is detrimental to strength.

The following table, based on experiments made by L. C. Sabin, an authority on the subject, shows the color results obtained from a dry mortar, the mortar containing two parts sand and one of cement:

Dry Material Used.	Weight of Dry Coloring Matter to 100 Lbs. Cement.				Cost of Coloring Matter. Per lb., Cents.
	½ lb.	1 lb.	2 lbs.	4lbs.	
Lamp Black	Light Slate	Light Gray	Blue Gray	Dark Blue Slate	15
Prussian Blue	Light Green Slate	Light Blue Slate	Blue Slate	Bright Blue Slate	50
Ultramarine Blue		Light Blue Slate	Blue Slate	Bright Blue Slate	20
Yellow Ochre	Light Green	Pinkish Slate		Light Buff	3
Burnt Umber	Light Pinkish Slate	-	Dull Lavender Pink	Chocolate	10
Venetian Red	Slate, Pink Tinge	Bright Pinkish Slate	Light Dull Pink	Dull Pink	2½
Chattanooga Iron Ore	Light Pinkish Slate	Dull Pink	Light Terra Cotta	Light Brick Red	2
Red Iron Ore	Pinkish Slate	Dull Pink	Terra Cotta	Light Brick Red	2½

Mix Coloring with Cement. In the production of colored blocks the coloring matter should be mixed with the cement so that in effect it will be colored cement that will be mixed with the sand. This method assures a thorough coloring of the block and a uniform shade throughout.

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PART IV.

Waterproofing.

The subject of waterproofing is one that has engaged some of the best talent and engineering skill of the country. In its application to concrete block or cement plaster residences it is of prime importance and should engage the attention of the owner when he is considering building with cement. The chemical properties of cement and the methods of its use are now so well known from practical experience that this problem is easy of solution.

It is unquestionably true that some of the cement buildings of the early stages of this form of construction were sadly at fault in the matter of waterproofing, and these examples of the misuse of cement were pointed out as proofs by the advocates of other materials as evidence that cement should not be employed in the building of homes. But a calm consideration of the matter and a close study of the subject by intelligent chemists and engineers solved the problem, so that now if any person builds a cement structure that absorbs too much moisture he himself is to be blamed for the information on the correct methods to pursue is easily obtainable.

The popular idea is that a house should be absolutely waterproof. All other materials used in building are to a greater or lesser degree porous, sufficiently so to take up or absorb moisture from the air and from rains. Some of the authorities seriously doubt whether it is conducive to the health of the occupants of a house to make it absolutely water and moisture tight. The ice water pitcher is cited as an example to show the wisdom of permitting a little porosity. In the summer time when ice is placed in the water pitcher and the glass becomes cold, moisture from the warm air accumulates on the outer surface of the pitcher, which, of course, is absolutely waterproof. The difference in the temperature of the pitcher's glass and the air of the room causes the condensation. When this condition is applied to a wall instead of a pitcher, one authority states, we see that in the case of an absolutely water-tight wall of a house, the air in the house in winter being warm and cold on the outside, we shall have condensation on the inner surface. We are inclined to coincide with this view in the case of a thin solid wall, but where hollow blocks are used or where an air space is provided the warm air of the interior of the house would cause no condensation on the walls for the reason that the air space keeps the cold from the inner section of the wall. It is unquestionably desirable from a hygienic viewpoint to allow for a little absorption in the walls, and the makers of the well known waterproofing compounds on the market have taken all these points into consideration.

Compounds and Liquids. There are good compounds that are mixed dry with the cement in proportions explained by the makers, and with these it is possible to produce any desired degree of density. There are liquids also for application to cement that have proved efficacious and either of these methods may be used.

Hydrated Lime for Waterproofing. A third method is the employment either of hydrated lime or any slacked lime. The use of this material in the proportion of one to ten of cement mixed dry has been found to make a mixture sufficiently dense to keep water out. Hydrated lime or slacked lime particles are finer than the particles of cement, so that by mixing them together the lime particles fill the voids of the cement. The two combined fill the sand voids. The three together should fill the voids of the stone, making a mass to all intents and purposes waterproof.

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PART V.

Cement Plaster Work.

This form of plastering is not new to builders, as it has been in practice in one way or another for many centuries. It is capable of treatment in a variety of colors to suit the taste and the material makes the most durable veneer known. It may be used to protect old buildings or for the finish of a new structure.

It is the common practice to apply two coats. The first is called the scratch coat. This consists of five parts Portland cement, twelve parts sand, three parts lime and a little hair as a binder. The finishing coat consists of one part Portland cement, three parts sand and one part slacked lime paste.

Applying Stucco to Old Walls. When stucco is to be applied to old walls they should first be thoroughly cleaned and the stucco applied after the walls are well wetted. The surface can be smoothed with a wooden float or roughened by rubbing with burlap.

Stucco on Frame Buildings. In the case of frame buildings tar paper is first put on. Over this strips are nailed vertically for the lath. It is the common practice in many places to use wooden lath, but these are not as satisfactory as expanded metal. The scratch coat should be applied half an inch thick and pressed through the openings in the lath and well around them to prevent rusting. The finish coat should be put on after the scratch coat is well set, the coat having been scratched well to make a binding surface for the finish. The finish coat may be one-half inch to one inch in thickness. If a spatter dash finish is desired it can be thrown on with a trowel. A pebble dash finish makes an artistic job. The mixture for this is one part Portland cement, three parts coarse sand and pebbles not over a quarter of an inch in size thrown on with a trowel.

Cutting with Hammer. Eight or nine cuts to the inch with a hammer also makes a good finish. The surface also may be "picked" with a brush hammer. To do this and produce anything like good results the forms must be removed before the concrete has had its final set and the surface gone over with a wire or stiff bamboo brush. Brushes of this kind will remove the skin or scale of cement and leave the stones of the aggregates exposed in their natural color. For the producing of good effects in this finish aggregates of varying color should be used.

Painting the Surface. In some localities a popular method of finish as well as the cheapest is to paint the surface with cement mortar. There is danger in this method of marring the effects by drippings if the work is done carelessly.

Use of Colored Aggregates. Pleasing effects are produced by the use of aggregates of uniform color, like crushed red stone or blue stone. The red stone gives a pinkish shade to the wall in conjunction with the cement.

Metal Lath for Building. Concrete steel exterior walls, such as are made ordinarily in the construction of residences, can be made in various ways. Expanded metal of three-quarter inch mesh is often used, being fastened to studding with sixteen-inch centers. This is considered superior to any other method, as the mesh is sufficient to permit the cement to pass through and cover the other side of the lath, thus protecting it. The ordinary sheet metal lath with protruding cups and opening cannot be covered on both sides. This variety is, therefore, not recommended for exterior walls, as dampness

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will soon rust the metal sheet. Another method satisfactory and effective is to cover the outside of the building with sheathing and place the plaster lath vertically about one foot apart. On this poultry netting of three-quarter inch mesh is placed and the plaster is applied. This

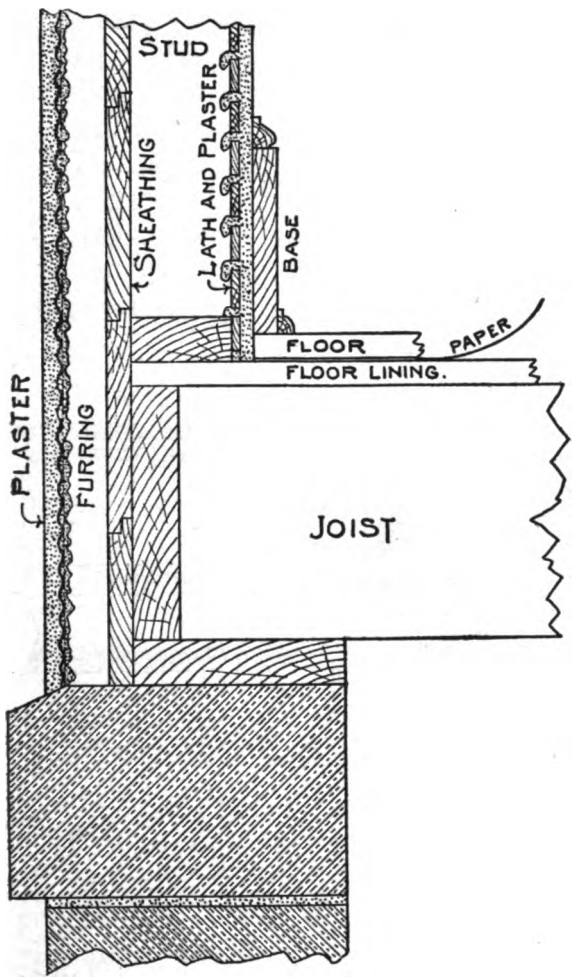

Fig. 29—General details of construction of a cement plaster house. Section showing work at first floor level.

will require less material than any other method.

Cement Mortar.

This consists of a mixture of Portland cement and sand in the proportions usually of one part cement and two of sand. The mortar should be made in a box. First, the sand should be measured and laid out in a layer. Then the cement should be spread on the top. The two should be turned dry till the uniform color will indicate that they are thoroughly mixed. The mass then may be hoed up to a form of a hill and a crater formed at the top for the reception of the water. The mixing should be rapid till the required consistency is obtained. In using cement mortar on brick it is preferable to have it too dry than too wet. Some workmen count on the bricks taking up the excess of the water in the mortar, but it is better to wet the bricks before they are laid.

Expansion and Contraction. The relative expansion and contraction of mortar under the influences of cold and heat interests the worker today fully as much as any question in modern building operations. The cement mortars of the highest grade are relatively stronger in their adaptation to the changing effects of heat and cold in solid walls than any of the cheaper grades. The proper crystallizing and hardening of Portland cement depends upon the mixing and the amount of water used, but in using such mortars with tiles and porous terra cotta any excess of moisture is generally absorbed by the building materials. This leaves the mortar in the very best condition for setting permanently. It also accounts for the firmer setting of mortar when placed between two bricks or tiles than when it is left exposed on the surface. After the proper crystallizing of the cement the quicker it sets the better must the results prove.

Fireproof Qualities. The destruction of mortar by heat is due more to the action of the fire upon the sand and broken stone incorporated with it than upon the cement itself. This has been demonstrated many times in tests and in actual experience. Where there is an excess of sand

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or broken stone mixed with the cement there is sure to be a lower degree of fireproofing in the mortar. This fact is not always sufficiently emphasized. In the effort to cheapen the cost of the mortar workers are tempted to add sand too freely in proportion to the amount of cement used, but not to such an extent as to actually weaken the strength or adhesiveness of the mortar. Those not accustomed to dealing with the fireproof work may not realize the enormity of their sin. The fact that they must consider the fireproof feature of their mortar as well as its strength should indicate to them the duty of maintaining the exact proportions of sand and cement. Concrete properly made is absolutely fireproof, provided it is thoroughly dried and contains no moisture.

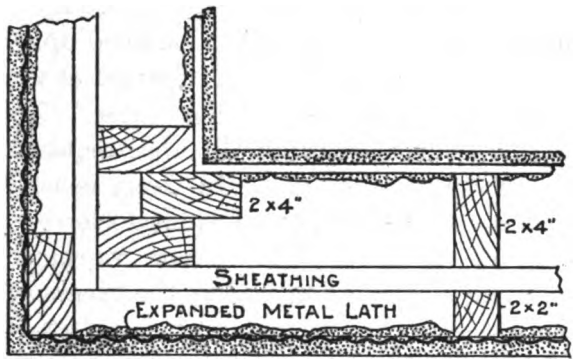

Fig. 15—Methods of constructing the corner of a cement plaster house and the use of expanded metal lath.

Hardness and Resistance. It has become an axiom of modern building laws that mortar should approximate the same resistance to heat and pressure when hardened and set as the building materials which it binds together. This in effect produces one compact mass in a wall. Mortar when employed between bricks, stones or building blocks sets much harder than when tested alone. This fact makes it easier for the worker to supply cement mortar which will set as hard as the building materials used. Unless the mortar forms a compact wall as hard as the blocks or bricks it becomes the weakest part of the structure. In fireproof buildings many defects have been found in the mortar simply through the neglect of this point by the men who did the work.

Fine Cement Best. Now, to have the mortar fireproof it is necessary to use a finely ground cement. The coarse parts of the best Portland do not adhere to sand or broken stone when moistened. It is thus necessary that the grinding of the cement be perfect as well as the burning, and to secure the best results uniformly, powdered Portland cement should be used.

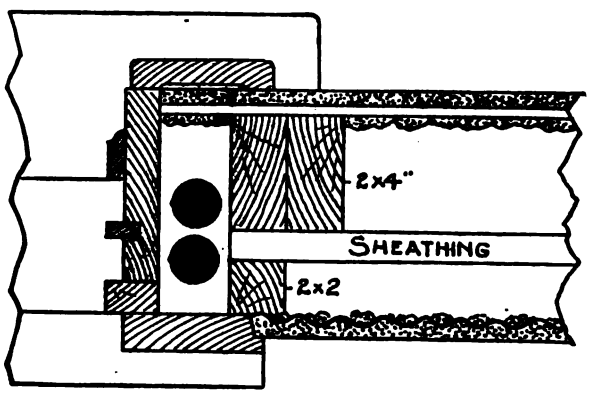

Fig. 17—Section of a window frame as constructed in a cement plaster house.

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PART VI.

Monolithic Concrete Construction.

By the term "monolithic" is meant all concrete work that is made in one piece, as for instance, a wall built by planking up both sides and filling in between the sides with concrete. When the plank is removed at the proper time the entire wall is left as a single block, or "one stone," as the word implies. The chief advantage of monolithic construction is that it permits of steel or truss reinforcements. In ordinary work where no steel is used its advantages are limited practically to the introduction of large stone in the aggregates. Thus in large work like foundations, retaining walls, dams, etc., very large stone may be utilized.

Advantages. The monolithic method has its advantages and disadvantages. One good point about the method is that no expensive labor is employed and that concrete steel floors, beams, etc., may be united with it. The disadvantages are the expansion of the planking or mold in tamping the concrete, causing a waste of material and the bulging of the wall beyond the true line. The concrete filling the creases, knotholes and other interstices can be overcome.

Care in Tamping. Monolithic concrete proves satisfactory in the building of basins, troughs, reservoirs and similar work, but much care is required, especially in tamping, to make the work water and frost proof. The voids also must be reduced to the lowest possible minimum by the use of various sized grains of sand in the aggregates, mixing the composition slightly damper than for ordinary tamped work and especial care must be taken not to jar or disturb the work after the tamping is completed.

Forms. In the making of forms material should always be used that is thick enough to make it certain that there will be no warping. For this work lumber that has not been seasoned is preferable to dry material, which is apt to warp when brought into contact with the wet concrete.

Unless the work is to have a finishing coat it is the usual practice to grease the forms. The bracing should be ample to stand all pressure. The longer the forms are left in place the better it will be for the concrete. It may be said as a general rule that not more than four inches of concrete should be placed in a form at one time, tamping each layer thoroughly.

A smooth surface can be secured by inserting a shovel or spade between the form and the concrete and working the tool back and forth. This motion will force the aggregates in the concrete back from the surface and leave only the cement mortar next to the boards when the shovel or spade is withdrawn.

Removing Forms. When the forms are removed extreme care is necessary to avoid disturbing the green concrete by touching or prying against it. Tightness is necessary in the forms for face work. Many make a practice of closing the joints and any other irregularities in the surface with the mortar, thin metal, plaster of paris or putty. This care will result in the avoidance of stone pockets or voids in the finished surface.

To assure the form being removed easily without having some of the concrete stick to it and thus injure the work crude oil often is used to grease the forms with before the concrete is placed. Soft soap and linseed oil also are employed for this purpose. Not too much should be used, only enough to fill the grain of the wood.

Proper Time to Move Forms. Many contractors have adopted the following

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rules governing the length of time forms shall be allowed in place:

Walls in mass work—One to three days, or until the concrete will bear pressure of the thumb without indentation.

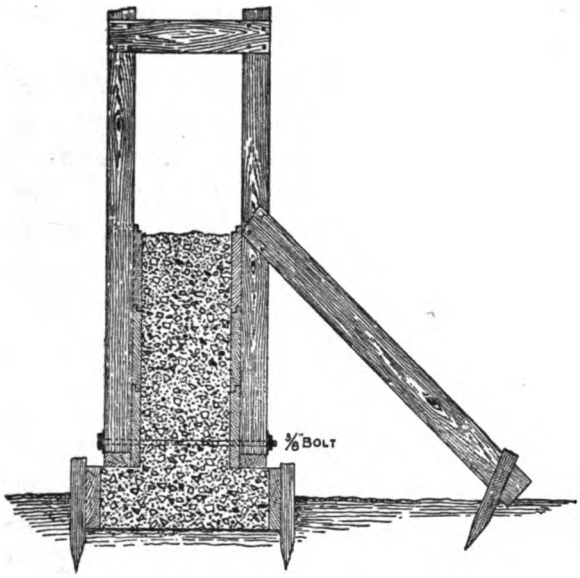

Fig. 16—Simple method of constructing the forms for a foundation wall. Note the footing and the method of bracing the forms to prevent bulging.

Thin walls—In summer, two days; in cold weather, five days.

Slabs up to six feet span—In summer, six days; in cold weather, two weeks.

Beams and girders and long span slabs.—In summer, ten days or two weeks; in cold weather, three weeks or one month.

Column forms—In summer, two days; in cold weather, four days, provided girders are shored to prevent appreciable weight reaching columns.

Conduits—Two or three days, provided there is not a heavy fill upon them.

Arches of small size—One week; for large arches with heavy load, one month.

All of these times are, of course, approximate, the exact time varying with the temperature and moisture of the air and the character of the construction. Even in summer during a damp, cloudy period, wall forms cannot be removed inside of five days, with other members in proportion. Occasionally two batches of concrete will set unusually slow, either because of slow setting cement or impurities in the sand, and watch must be kept up to prevent the forms being removed too soon. Trial with a pick may assist in reaching a decision. Beams and arches of long span must be supported for a longer time than short span because the dead load is proportionately large and, therefore, the compression in the concrete is large even before the live load comes on it.

Color Variations.

One of the difficulties encountered in plaster and monolithic wall construction is a variation of color between the various layers of concrete that are deposited, and also the tendency in monolithic walls of the aggregates and stones to show on the surface, separating themselves from the matrix, or cement. This variation of color may be due to variation in the character of the sand or to non-uniformity in proportions or mixing, or possibly to other causes. An artistic method of overcoming these difficulties is to cut the surfaces by grooves or channelings, giving the surface the effect of stone work. For this purpose the V-shaped form has been found to be best adapted. The V is placed in the form at intervals of eight or ten inches and when filled produces the familiar panel finish.

Proper Finish. Monolithic construction, to bring the cost of mill work for the forms within reasonable bounds, should be of simple design, involving no elaborate or intricate detail of mouldings or cornice effects. The use of the quarter round is suggested and all forms should be beveled so that they will pull away readily from the concrete without breaking off any edges. The proper finish for all exteriors of monolithic buildings is being given

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much attention by architects. It has been found that no matter how carefully the forms are made, when they are removed the wall has a cast appearance that is not desirable. A method frequently adopted to remove the pasty texture of the surface is to use a sand blast. This gives the surface a rough appearance, but in most cases the edges of the seams have to be dressed by hand.

Rubbing Down. Another finish has been obtained by oiling the forms and rubbing down the work after it is finished with carborundum blocks, and using cement paint, which is made with cement and water. The carborundum block cuts away the irregularities on the surface and the paint fills in the crevices, the two producing smoothness. Of course in the case of a very large building this would be a laborous process, but for a residence it is not a difficult or expensive operation.

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PART VII.

Reinforced Concrete.

The history of reinforced concrete has been published so often that it is not necessary to refer to it in a volume that is devoted to the everyday practical problems of the cement industry. Sufficient to say, that reinforced concrete has been attracting more and more interest among engineers and builders since the series of demonstrations and tests that were conducted by Thadeus Hyatt, an American, in England in 1876 and 1877. He made many tests of reinforced beams in Kirkaldy's laboratory, developing at that early day the advantages of the system in many ways. In the matter of the cost of reinforced concrete it undoubtedly is cheaper than steel or concrete alone.

Expanded Metal Meshing. One of the systems that is growing constantly in favor is expanded metal meshing. It is popular in favor because of its lightness and adaptability to light forms of construction like ceilings, lathing for concrete plaster and for partition work in dwellings.

Columns and Piles. The number of steel rods used in columns and piles for reinforcement varies from four to twenty and the diameters vary from ⅜ to 2½ inches. In order to give the greatest serviceability and strength the rods are placed as nearly as possible to the outside of the column. Columns of this character are made in molds in which the rods have been arranged and the concrete is poured in, being rammed with hand hammers.

Reinforced Walls. This method of construction in monolithic work is being extensively practiced. Rods the entire height of the wall are placed when the filling in is commenced, varying from ½ inch to 2 inches in diameter, depending upon the size of the wall. For an ordinary wall for a house, eight inches in thickness, rods of ½ inch are used in two and three rows six inches apart. A wall thus constructed will stand any stress of wind or jar that may be brought to bear upon it. The same method is recommended for barns.

Examples of Strength. The strength of reinforced construction and its superiority over stone or frame building was proved by the San Francisco earthquake. The museum building of San Francisco, and the Girls' Dormitory of Leland Stanford University, among the first reinforced concrete buildings constructed in the United States, withstood the earthquake and fire unscathed, while buildings of brick and natural stone in their immediate vicinity were completely wrecked.

Tension and Compression. Concrete, like stone, is weak in tension, one writer says, but is strong in compression, at a ratio of 1 to 10. Consequently, when under pressure, as in a beam, the concrete is not used economically, for it breaks on the lower side before the compressional strength is utilized. A beam may be, however, strengthened by the insertion of a steel rod in the lower part of it. These rods are usually bent up near the ends of the beam so as to also reinforce the beam against the diagonal tensional stresses that occur at the ends, due to the combination of sheer and direct stress.

Adhesion. Before the rod can come into operation during the flexure of the beam there must be the necessary adhesion between the concrete and the rod to transfer the stress to the rod. This adhesion or bond varies from 200 pounds to 500 pounds per square inch of the surface of a plain rod, and under favorable conditions is sufficient to develop the strength of the steel in the concrete. The adhesion is thought to be more of a mechanical action than

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chemical, and is due to the entrance of the fine cement into the microscopic pits on the surface of the smooth rods. Many designers use artificially deformed bars, such as corrugated bars and twisted steel bars, to increase this adhesion.

Vibration. Some engineers have feared the effect of the long continued vibrations on the bond of the steel or the strength of the concrete. It is well known that concrete because of its lack of elasticity absorbs or deadens vibrations and the sound caused thereby. It is not probable that vibrations reach the steel. So far bars that have been subjected to long continued vibrations seem not to have lost any of their strength of bond.

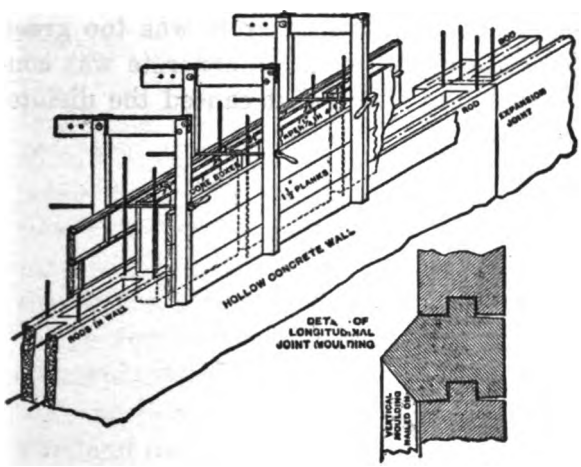

Fig. 6—Method of form construction for a hollow wall. Notice the reinforcing rods and how they are placed.

Placing Reinforcing Rods. In placing reinforcing rods they are always placed where the greatest strain will be, as it is their office to overcome that strain. In the case of beams the greatest strain is at the bottom, as it is easy to see. The rods, therefore, should be placed near the bottom of the beams and just inside the lower surface. The same is true of concrete slabs for roofs, etc. The quantity of concrete outside the steel should be only enough to protect it from rust or fire. If the rods were placed near the top of a slab or a beam there would be very little weight carrying power.

Average Size of Beam. The following table of dimensions is suggested for reinforcements of beams of the ordinary sizes:

FOR PRESSURE 125 POUNDS PER SQUARE FOOT.

8	4	6	13	1½	3	½	¼
	6	7	15	1½	3	⅝	⅝
	8	8	17	1½	3	⅝	⅝
10	4	7	14	1½	3	½	⅝
	6	9	17	1½	4	⅝	⅝
	8	9	20	2	4	⅝	⅜
12	4	9	16	1½	4	⅝	⅝
	6	10	39	2	4	⅝	⅜
	8	11	22	2	4	¾	⅜
14	4	9	16	1½	4	⅝	⅝
	6	10	20	2	4	⅝	⅜
	8	11	22	2	4	¾	⅜

FOR 50 POUNDS PER SQUARE FOOT.

8	4	5	10	1¼	3	⅜	¼
	6	6	13	1½	3	½	¼
	8	7	13	1½	3	½	⅝
10	4	6	12	1¼	3	⅜	¼
	6	7	15	1½	3	⅝	⅝
	8	8	16	1½	3	⅝	⅝
12	4	7	13	1½	3	½	¼
	6	8	17	1½	3	⅝	⅝
	8	9	18	1½	4	⅝	⅝
14	4	7	15	1½	3	⅝	¼
	6	8	19	2	3	⅝	⅝
	8	10	21	2	4	¾	⅜

This table is given only for the construction of beams of the sizes indicated.

Large Beam. For larger beams an engineer should be consulted, especially if it is a matter of construction in which very heavy weights will be required. The rods used in beam reinforcement are run lengthwise of the beam, and one-half or one-third of them are bent up about one-third way from each end and extended over the supports, and U-shaped bars or stirrups, which pass under the longtiudinal rods and up on each side of the beam. The horizontal bars withstand the direct pull in the bottom of the beam when the beam is carrying a load, while the U-shaped bars and stirrups prevent diagonal cracks, and the bars passing over the supports prevent the cracking of the beam on top at the ends.

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Proportions for Beams. The concrete used in making beams should contain aggregates not over one inch in diameter and the mixture should be of the consistency of heavy cream to insure its setting closely around the rods at all points.

Reinforcement for Tanks. The following table for reinforcement of tanks is suggested:

5x 5	4	¼	6	9	⅜	1½
5x10	4	¼	6	9	⅜	2½
10x10	8	⅜	6	12	⅜	2½
10x15	8	½	6	12	½	3
15x10	12	½	6	15	½	2½
15x15	12	⅝	6	15	⅝	3

Concrete as a Fireproof Material. Concrete is generally assumed to be and accepted as being fireproof. The later laws on the subject generally accept it as fireproof and prescribe the minimum thickness to be used for covering embedded metal. It cannot be denied that concrete is incombustible, but that it will not disintegrate under stress of great heat cannot be maintained. The New York building authorities have made fourteen tests on concrete constructions, seven of which proved successful. It seems that in the case of the building that failed to stand the test the concrete was too green and the moisture in the concrete was converted into steam that caused the disintegration.

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PART VIII.

Sidewalks, Pavements and Floors.

Foundation. The first step in making concrete sidewalks is the excavation of the ground and preparation of the surface by ramming for the reception of the stone, gravel or cinders. In localities where the frosts are heavy the ground should be excavated to a depth of twelve inches. In milder climates it need not be excavated further than six inches. An average thickness for the sub-foundation is six inches, although if the ground is always dry it need not be more than three. The sub-foundation—stone, gravel or cinders—should be well pounded down to assure its being firm. The practice in some localities is to permit cinders to lie for some time in place before operations of laying the walk are commenced.

The foundation consists of a layer of concrete topped by one of cement mortar.

Proportions. In the making of walks Portland cement should be used. The proportions for the concrete are about 1:3 and a depth of 3 to 4 inches is required. The stone or gravel should be 1 inch in size. Local conditions may change these proportions, however. The cement mortar for the top dressing should be mixed in the proportion of 1 part cement to 2 parts sand.

Measurements. As a guide in excavating a cord stretched between stakes will do, after which the bottom of the trench should be rammed. The next step is the driving of stakes along the sides of the walk with their tops made even with the finished parts of the walk. There should be a slight slope transversely, a quarter of an inch to a foot, to provide drainage. Two by fours are nailed to the stakes to serve as molds for the concrete. They should be adjusted carefully so that they may serve as guides for the straightedge in the leveling of the foundation and the top dressing.

Putting on Concrete. The concrete is deposited after the sub-foundation is sprinkled to receive it, being leveled off with a straightedge, leaving about an inch of space below the level of the mold for the reception of the top dressing. Before this is put on, however, the concrete is well tamped. Sand joints of three-eighths of an inch are provided at intervals of six to eight feet to prevent expansion cracks. This operation is performed by dividing the concrete with a spade and filling the space with sand.

Troweling. That the top dressing and the concrete may set together it is necessary to follow up the depositing and leveling of the concrete closely with the last coat. The top is worked over the concrete with a trowel and leveled with a straightedge to make the surface even. As soon as the film of water leaves the surface a plasterer's trowel is used till the surface is perfectly smooth.

Dividing. The next step is the division of the surface into sections exactly over the joints in the concrete. This is done with a trowel and straightedge. Then a tool called a jointer is used to give the top a finished appearance. An edger is used to finish the sides of the walk next to the mold, giving the edge a smooth rounded appearance.

Pavement Foundations. Nothing in the constructive line gets more wear and tear than pavements. Good pavements have been the problem of cities for ages and cement has proved itself among the best of materials for building them. But the matter of a good foundation in a pavement is as important in this connection as it is in the matter of a house. Without a solid, fixed foundation it is impossible to build

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good pavement even with cement. In a general way it may be said that foundations consist of two parts, the bottom, or natural foundation, and the upper or built part. The first is sometimes called the "bottom" and the other the "foundation." In cases where the ground is soft there must be thorough ramming before sufficient to assure a good job. The heavier the traffic that the pavement must stand the materials are placed on the bottom.

Depth and Thickness. As to depth from the bottom to the finished surface it may be said in a general way that six inches is the greater the depth should be. Stone, brick and rubble make a good foundation. It is better to break them on the ground so that the pieces will not be over two and one-half inches. During the process of breaking the smaller particles will go to the bottom and help fill in. The concrete foundation should be from four to seven inches thick, varying according to the amount of wear the pavement must endure. The aggregate should consist of broken bricks, coke breeze or hard clinkers and should be gauged to the proportion of one part cement to five or six of aggregate.

Laying Pavements. In placing the top layer of the pavement it should be always borne in mind that a little excess should be deposited to allow for ruling off and to make sure that all parts of the surface are filled. The most important part of the operation is to make certain that the mixture is rammed into the foundation and that all parts of the lower stratum are filled to guard against air spaces or bubbles that weaken. Concrete that is well compressed gains much in strength and this feature must not be overlooked in a pavement.

A Good Surface. Perhaps the best surface is made of one part Portland cement, one part sharp sand mixed dry, then add one part granulated furnace slag, and proceed in the usual manner. The slag being porous would consume most of the cement if all mixed at once, as is done in other concrete. The concrete for sections of the size mentioned should be four inches thick if reinforced with netting, and seven inches thick if no reinforcement is used.

The wearing surface, which should not be measured with the concrete, is made of such thickness as is required. In residence streets one inch is thick enough, but on commercial streets not less than two inches should be laid and three would be better. If the noiseless pavement is to be used this thickness should be increased at least one-half.

Expansion Joints. Sand and tar paper are used in pavements and walks or in any concrete work of large space that is exposed to changes of temperature to prevent cracking when the material expands or contracts. This provision should be made in every piece of concrete work subjected to wide variations of temperature. It takes but little extra trouble, but will result in preventing cracks and make the work of a more lasting character.

Sand Joints. What is considered the best method in making sand joints for concrete walks to prevent cracking due to frost is as follows: Lay a 2x4 between the strips and cut through with a spud about six inches wide and one-fourth of an inch thick with a blade 4 or 5 inches long. The spud should have a "D" shovel handle on top. Cut through and make a clean, open cut about 3-8 of an inch wide. Then pour in dry sand, or if dry sand is not at hand work wet sand down. The sand should be scattered evenly all over the bottom coat so that it will make no partings whatever at the ends, then cut it back well in order to avoid breaking the corners.

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Curbing. Concrete curbing should be built in advance of the walk in sections varying from 6 to 8 feet long. They should be separated from each other by tar paper or a sand joint to allow room for expansion in various degrees of temperature and prevent cracking. The curbs should be 4 to 7 inches wide at the top, and 5 to 8 inches at the bottom, with a face 6 to 7 inches above the gutter. The base for the curb should be 5 to 8 inches thick and should consist of a porous material at least 12 inches deep. The gutter should have a base of like thickness and should be 16 to 20 inches wide.

Digging Trench. The first operation is the excavation of the trench. This should be dug so that the bottom will be even and uniform and of a width equal to the combined width of the gutter and curb. On top of this place the sub-base or foundation of porous material (it may be cinders), and place the forms that, of course, have been prepared previously. One form of a well dressed surface will be required for the outside surface. The inner form should be made to shape the inner surface of the curb, the gutter and the inner edge of the gutter.

Mixture. The mixture for the concrete should consist of one part Portland cement, three parts clean, coarse, sharp sand and six parts broken stone, all thoroughly mixed. Fill the forms to about three inches below the completed level desired, tamping the mixture thoroughly. As soon as the concrete is set sufficiently to withstand pressure, place a third form for the formation of the curb. It should be an L-shaped form, the bottom equal to the width of the gutter and the upright part made to shape the inner surface of the curb. The mixture to be used now should consist of one part Portland cement, two and one-half parts clean, coarse sand and five parts broken stone that will pass a half-inch mesh.

Finishing Coat. The finishing coat after the forms are removed should be of cement mortar (one part cement and two of sand). Trowel thoroughly and smooth with a wooden float. The surface should be sprinkled and protected from the sun.

Concrete Floors.

Veranda Floors. Concrete floors for verandas, porches and even balconies are much to be desired. While they cost a little more than wood, they are imperishable. Such floors may be built on the ground the same as walks, or on rough wooden supports. One part of Portland cement, three parts of sharp sand and three to five parts of gravel mixed with sufficient water to become plastic, and tamped in position to a thickness of 3 inches is the rule. The wearing coat is a half inch thick and made of one part Portland cement and two parts sand. The top coat should be smoothed with a plasterer's trowel and allowed to stand for six to eight days, being kept damp.

Basement Floors. In a general way, the same rules apply to this work as are used in the making of concrete walks, except that in dwelling houses not so much strength is required. The one exception that should be mentioned is in houses where the basements may be wet. There greater strength is necessary. Thorough draining of the sub-foundation is required, even if it is necessary to use tile to carry off the water. If the sub-foundation is not drained, water will force its way up through the concrete and the top dressing. The thickness of the concrete foundation usually is 3 to 5 inches, and for the average work, a 1-3-6 mixture is rich enough. It always is a good plan to provide expansion joints, although they are not as necessary in interior

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work as in sidewalks. The omission of them may give rise to unsightly cracks. The floor should be given a little slope to some given point, where provision should be made for carrying off water used in cleaning the basement or from overflows.

Stable Floors. The dairyman and agriculturist are more and more coming to recognize the concrete floor as the ideal for barn and stable. Excavation for work of this kind should be made below the frost line and there should be a sub-foundation of at least six inches and even more if possible, depending upon the weight and wear the floor is to have. A deposit of five inches of concrete should be made upon this sub-foundation consisting of one part Portland cement, three parts sand and five of crushed stone or gravel well mixed. The top coat should be two inches thick, one part cement and two of sand. The surface should be so sloped that the liquid manure and water of the stable will flow to some desired point for drainage away. The top should be grooved before it sets to give the animals foothold and prevent their slipping. If the floor is to be of more than ordinary size, it should be laid in sections and provided either with sand joints or the sections separated by pieces of tar paper.

Jointless Floors. The use of jointless flooring, made from pulverized wood fibre and other material and laid in a plastic state on a cement foundation, was begun in Germany about ten years ago. This flooring has proved so successful that several other mills manufacturing the same product have been started and are now running prosperously. The problem has been to make a continuous flooring, which will fit closely at its junctions with the upright walls and be not only fire proof, but impervious to liquids, dust and vermin of all kinds. The experts at work on the problem hope to succeed in producing a flooring, too, that will be a poor conductor of heat and sound, easily cleaned, neat and attractive.

Grooved and Roughened Surfaces. The stable yard and the stable floor, carriage runways and all places where it is intended to have animals use the concrete floor are made better by being grooved or roughened. This treatment of concrete prevents the animal from slipping and gives a foothold to the floor, besides affording drainage for water to some common point where it can find egress. Concrete surfaces may be roughened also by beating them with a brush before they are hardened.

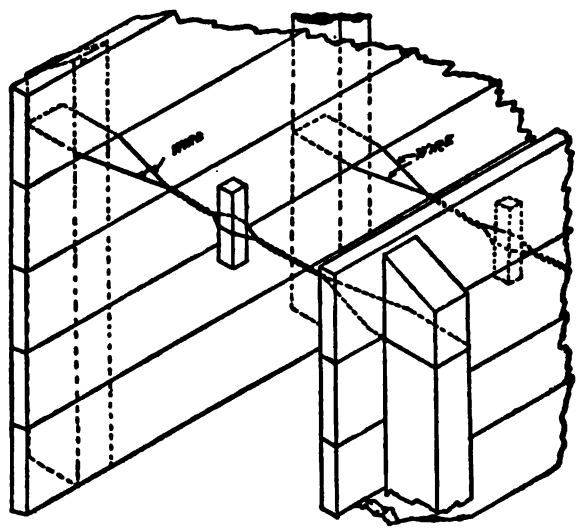

Fig. 5—This illustration shows the use of wire for holding wall forms in position.

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PART IX.

Walls and Foundations.

House Foundations. As a general rule the base of a wall of any kind should be at least fifty per cent wider than the wall itself. For instance, a 12-inch wall should have a face of 18 inches and sufficient thickness to prevent settling. It should be remembered in building the base of a wall that the entire weight of the building and all its contents is to rest thereon. The stronger the base the more lasting the building. Another important factor is the necessity of starting a wall below the frost line and below soft or yielding soil.

Excavating. In building the foundation for a house the first step is the excavation to the desired depth of the cellar or basement. Around the edge dig a trench eighteen inches wide and six inches deep and here build forms for a wall twelve inches wide.

Proportions. The concrete for the wall should be one part cement, two and one-half parts sand and five parts broken stone or gravel. It should be rammed carefully and the concrete at the bottom should be allowed to flow out and fill the trench to the desired height. The concrete should be allowed to set hard before removing the forms. In clay soil the outside of the foundation wall should have a good coat of cement mortar. If earth is filled in against the back of the wall the face forms should be left for three or four weeks, but the superstructure may be begun in about a week, contingent of course upon the weather conditions.

Partition Walls. In the case of partition walls they need not be more than eight inches thick. If they are reinforced with ¼ inch iron rods spaced 18 inches apart horizontally and vertically, they need be only 4 or 6 inches thick.

Barn Foundations. They are laid in the same manner and of the same proportions in the mixture as house foundations, except that there is no cellar unless it is desired.

Comparative Cost of Walls. This will vary with the locality and with labor conditions. The comparative cost of a wall built of brick, concrete blocks or monolithic concrete molded in forms may be given as follows: Brick at sixteen dollars a thousand laid in the wall. Concrete blocks will cost thirteen dollars and eighty cents for the same space, while monolithic concrete should cost eleven dollars to fill the same space.

Concrete Blocks for Foundation Walls. For basements less than twelve feet in height, a wall eight inches thick is sufficient for supporting a two story frame building. The size of the blocks is a matter of taste, but no block should be larger than four times its height or less than one and one-half times its height. The best builders favor blocks that are two times as long as they are high. Crushed stone that passes a three-quarter inch screen is best for

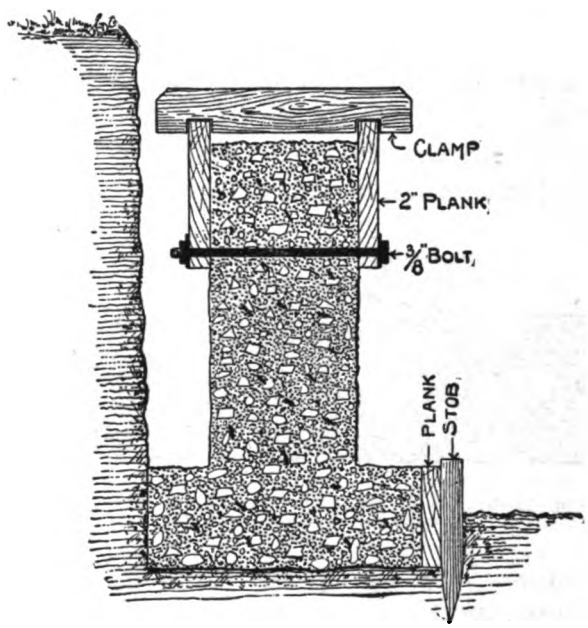

Fig. 22—Clamp and bolt method of form construction for a cellar wall.

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strength, although it is rough in appearance. The best proportion of ingredients is cement one part, sand three parts and crushed stone one and one-half parts.

Corrugated Concrete Piles. One of the most marvelous uses to which concrete has been put recently is its employment in the shape of piles driven into the earth to serve as foundations for heavy buildings. The piles are sent down either to bed rock or to hard pan. In a number of cities in the east, this form of foundation has been used successfully. The piles are made in octagon or hexagon shape with grooves that are uniform in width the whole length of the pile; altogether the pile is possibly sixteen inches across at the top and may be eleven inches at the bottom. The reinforcement is ⅜ inch wires, 3 inches on centers longitudinally, with approximately 1-8 inch wires, 12 inches on centers around the pile. A hole through the pile is made 3 1-2 inches in diameter at the top and 2 inches at the bottom. This hole is made tapering so that more concrete may be provided for the bottom of the pile and so that the plug which forms it may be withdrawn.

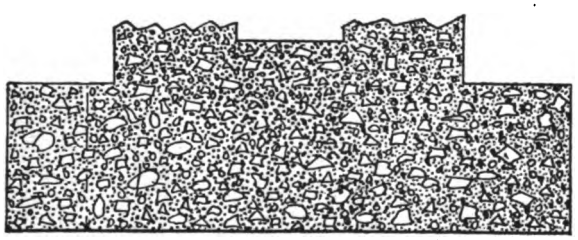

Fig. 20—Section of footing for the foundation of a concrete wall for a residence.

This hole through the pile is an important factor in the driving of it. A jet of water with tremendous pressure extends through the entire length of the pile and protrudes three inches below the bottom. The action of the water is sufficient to dig a hole and carry the loosened sand and earth up the corrugations on the exterior of the pile which act as an exhaust for the jet. The weight of the hammer pushes the pile down into the hole as fast as the water makes room for it. When the pile is nearly in place the hammer and cushion cap are hoisted up, the jet is removed, the cushion cap is again lowered over the head of the pile and the hammer forces the pile down till it refuses to go further. On the top of the piles a foundation of concrete is laid, making practically a solid foundation of concrete down to bed rock or to hard pan, as the case may be.

Another method is called the pile core plan. It consists of a collapsible steel pile core, in shape something like a cone. A metal shell is provided into which it fits closely. The method of sending the core down into the ground is the same as for driving wood piles. The force is exerted on the shell, sending it down. When the desired depth is reached the core is collapsed and withdrawn, leaving the shell in the ground. Then the concrete filling is placed, the shell acting as a form.

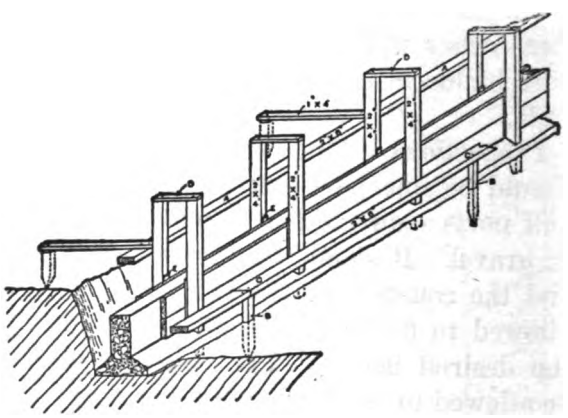

Fig. 4—The form shown here is for a foundation wall. It will be noticed that the form is braced at frequent intervals.

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PART X.

Steps and Stairs.

These are of two classes, those of the monolithic form (one stone) and those that are made in pieces and put in place. There are many opportunities in extensive grounds about country residences where concrete steps may be built to advantage, adding much to the general appearance of the place.

The risers (the edge of vertical section of a step) should not be less than 6 inches or more than 8 inches, while the tread (the top of the step) may vary from 10 to 14 inches. In cases where it is intended that more than one step may be taken on a tread, a width of thirty inches may be provided. This, of course, would be in a series of steps out of doors, as on a terrace or hill.

Foundations for all steps out of doors should be extended below the frost line, or have a porous base with a drain situated at the lowest point to allow the water to run off. It is essential, too, that steps should be wider than the walk, or opening from which they lead, to prevent their having a cramped appearance and give them an artistic effect. The tread should have a slight projection, as a plain molding effect and should slope sufficiently to allow water to run off.

The reinforcement of steps and stairs cast separately is required. Iron bars should be placed about one inch in from the bottom step.

Concrete Steps. Steps made of concrete often are the handsomest that are seen in residence neighborhoods, dependent of course upon the style in which they are made and their harmony with the architecture of the house. Vertical boards are placed commencing at the top, to give the risers the thickness required. It is necessary that they project high enough to be guides in leveling off the top. The matter of reinforcing is dependent entirely upon the weight that the steps will have to carry. Reinforcing may be done by placing steel rods bent to the shape of the steps and so placed that they will be inbedded in the concrete, one at each end of the steps. For the risers, two vertical forms should be used for their formation. It will be well to use as the front one, a steel plate that can be removed readily. For this work Portland cement should be used. The wearing surface should be a half inch thick.

Steps on Terraced Grounds. Excavate on the slope, allowing for four inches of sub-foundation and four inches of concrete. Put in the sub-foundation of cinders or broken stone or bricks, providing a drain at the lower end to carry off any water that may accumulate. Concrete work often is ruined by water freezing under it and expanding. Place a plank along each side of the proposed steps, providing one wide enough to take in the rise of each step. The planks should be well braced their entire length to prevent any bulging. Lay a strip of woven wire fabric, or other reinforcing mesh, of a width nearly corresponding to the width of the steps and the full length of the steps on the slope. The next operation is to spread on the wire a layer of concrete about three inches thick consisting of one part Portland cement, three parts clean, coarse sand and six parts broken stone or gravel. Sufficient water should be used to make a mixture that will work through the wire cloth and completely surround it. Tamp well and permit the concrete to stand for twenty-four hours. Starting at the top place the boards between the planks to form the risers of the steps. The inner top edge of each board should be grooved in a circular form to form the bottom of the nosing of the tread. Each board

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should be fastened securely to the planks. Just before the next mixture of concrete is applied the base of the concrete laid before should be wetted. The forms should be filled with a mixture consisting of cement mortar, one part cement and two parts clean sharp sand. Trowel the top and round at the edge to conform with the groove in the riser board.

Porch Steps. Build two 8 inch walls to a depth below the frost line, and make sure that the upper surface conforms to the desired pitch of the steps, but three inches below the point where the inner edge of the tread meets the rise. Between the walls build a platform out of 2x4 stuff, well braced and conforming to the slope of the walls. Over this and over the top edge of the walls, put a three-inch layer of concrete reinforced every foot by 1-4 inch iron bars running from top to bottom. Build up the form on the outside of the walls and proceed in the same manner as for terrace steps. Should the steps be more than 6 feet wide a wall similar to the two side walls should be built in the center to assure sufficient strength. The forms should not be removed from under the steps for 28 days. If more than three or four steps are required the iron rods must be of larger size and nearer together.

Flying Stairs or Steps. In the construction of this type of concrete work the steps are made in the same manner as in constructing cast steps; that is, each step is cast separately and given time to cure or season. The stringers of the desired length are cast in place with reinforced concrete. The reinforcement consists of two 3-4 inch iron bars. One is placed about one and one-half inches in from the bottom of the stringer and the other about the same distance from the top. The stringers, too, are provided with a projection along the lower inside to support the steps. A finishing coat of one part cement and one part sand is given the stairs after they are all in place.

Platform Steps. The best proportion to use is one part cement and four to five parts sand. Blocks thus made will resist wear well. For the wearing surface one part cement and two parts sand will be better, but the wearing coat need be only half an inch thick, provided both coats are mixed and used at the same time, allowing the cement in both mixtures to unite. Wood molds made of surfaced lumber coated with liquid shellac, oil or paraffin will not adhere to the cement. The proportion of cement and sand is necessary to secure uniform and sound work as well as color. Plaster for the outside work should be made of cement, as the lime disintegrates, besides fresh lime requires much more water than cement, hence they never should be mixed together. Cement always contains sufficient lime that has been properly treated, so that no more lime is required unless a cheaper product is wanted.

Cast Steps. Steps made in this manner should be given plenty of time to season before they are used or put in position. The making of cast steps is similar in a general way to the making of cement blocks, in that a form is used. This form should be of plank and the inner surface should be smoothly dressed. One side of the top edge should be grooved to provide for the projection of the tread over the riser. The concrete should consist of one part cement, three parts sand and six parts broken ½-inch stone. Fill the box or form with the mixture to within one inch of the top, leaving that space for the finishing coat which should be put on immediately. Dress the top with one part cement and 1 and 1-2 parts sand, rounding the edge to conform with the groove of the projection. After the cement is set and hardened the form

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may be removed and used for another step.

Side Walls for Steps. In building the side walls for steps of this character the foundation should be twelve inches wide and start below the frost line. On this foundation and at equal distances from each edge, erect eight inch walls, stepped off to conform to the width and depth of the cast steps. Place the cast steps on the walls thus made, covering the joints and finishing neatly with cement mortar. If the steps are more than three feet long they should be reinforced with 1-2-inch iron rods placed in the center of the steps about three inches apart.

Making the Slabs. The formula for concrete used in this work is one part Portland Cement mixed dry with 2 1-2 parts of crushed slag and granite equally. The granite and slag should be of a size that will pass through a 1-3 inch sieve. The method of mixing is mechanical. The parts are placed in a horizontal cylinder and thoroughly mixed. The mold is placed on a shaking machine after being previously oiled and after the machine, which gives to the mold a rapid vertical motion, is started the concrete is laid on the mold in small quantities and it is smoothed off with a trowel. The molds are removed and permitted to stand for three days. Then the slabs are taken out and stand five days more. A silicate bath is then used for immersing the slabs, and they are allowed to remain in this a week. After this process the slabs are taken out and are dried in the open air. It is not thought best to use them for three months.

Paving Slabs. The method of making paving slabs is to ram and beat the concrete into the mold by an iron hand float.

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PART XI.

Concrete on the Farm.

Throughout the greater portion of the country the pioneer days of hardship and forced economy are over. These conditions led to flimsy construction, but the time has come now when the farmer can use better materials in his constructive work. All that is needed is that he shall understand the value of concrete for this purpose, its adaptability, endurance and permanency. When this material is generally adopted in this manner in the rural communities, this country will be on basis structurally with the old countries of Europe.

The many uses to which concrete may be put by the farmer to insure to him durability and that imperishable quality so much to be desired is being recognized more and more. Certain well defined rules in the construction of concrete work, based on the experience of others make the handling of cement by even the inexperienced an easy matter provided, of course, that the rules are adhered to.

Any material that assures to the agriculturalist the certainty that what he builds will last not only during his lifetime, but during that of his children and his children's children, is to his advantage. And when it is considered that he can employ cement in making his improvements at a cost not exceeding that which he would have to pay if perishable lumber or timber were used, it is evident that concrete must be adopted generally by the wise homemaker and the agriculturalist.

Concrete Sewer Pipe. In the draining of marsh land and for sewage purposes pipe made of concrete is not surpassed by any other material. Pipe of this kind has been made many years in Germany, the matrix being Portland cement. Rudolph Hering, a New York engineer, who has investigated the subject, says:

"Cement sewer pipe has a competitor in the United States perhaps to a greater extent than elsewhere, in vitrified clay pipe, which is very extensively made in our country, and is still almost exclusively used for small sewers. As cement pipe can be made cheaper than clay pipe, it is naturally forcing itself into use."

Mr. Hering claims the following advantages for concrete sewer pipe over the clay variety:

A sectional form can be given them which is more conducive to stability and efficiency than round clay pipes.

As vitrified pipe warps in burning the section is not finished truly circular, and slight projections are formed at every joint when the pipes are laid to form a sewer.

As cement pipes have a truer sectional shape than vitrified pipes, they can be given a slanting butt joint, as is customary in Europe, instead of the more costly bell and spigot joint common for vitrified pipe, which are made in imitation of cast iron pipe used under high pressures.

Concrete pipes are tougher and less brittle than vitrified pipes.

Concrete pipes, if well made of proper materials, have a strength to resist compressive, tensile and bursting strains which is amply sufficient for all purposes for a sewer in a large city. If the materials are carefully selected, the concrete pipe should be as permanent as the vitrified pipe. Concrete work in the sewers of Paris several hundred years old is as sound today as when it was laid. For the manufacture of concrete sewer pipes, a number of machines are on the market and when the aggregate used is carefully selected and cleaned, the mixture of 1 part Portland cement, 2 1-2 of sharp, coarse sand and 4 parts crushed stone not over half an inch in size, a good pipe should be turned out.

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Circular forms of steel should be used and the tamping should be done in the same manner as for concrete blocks.

Culverts. It may be said of the concrete culvert that it will be found intact after a flood or freshet, while brick or stone culverts in the same neighborhood will be washed away. It is true too that they are cheaper than culverts made of any other material, besides being more durable. It need only be mentioned that the only time to build a culvert is in a dry season when there will be no difficulty with water. When this is not practicable, the water may be diverted possibly. In this work, as in all other operations where concrete is to be placed on the ground, excavation must be carried below the frost line. Trenches for the foundation should be dug on each side of the bed of the stream. The concrete should be of one part Portland cement, three parts sharp, clean sand and six parts of crushed stone or gravel. Build an apron with this concrete across the bed of the stream between the two foundations and with its level equal to the bed of the stream. For a culvert of ordinary length this should be eight inches thick. Place the semicircular arches of the size required and brace them well. Two inch plank should be used for the forms. After the forms have been well greased, fill in the concrete, tamping thoroughly every four inches. A reinforcement of expanded metal should be placed inside the surface of the arch about two inches.

A Concrete Fountain. In the adornment of the rural lawn, nothing adds so much to the attractions of a home as a fountain. Any family owning a windmill and elevated tank has the equipment for an improvement of this kind that will be a source of delight in the summer months. The plan here suggested is for a fountain having three basins and six feet high. The lower, or fountain basin, whose edges should be elevated above ground level about four inches, is five feet in diameter. The middle basin is three feet and the top two feet in diameter.

The first step, after the desired size is determined, is to make the pipe connections and provide for the feeding arrangements for the fountain. A pipe frame should be made, or skeleton of pipe, with the provisions for the spouts of water, all of which should tend a little inward to get a centralization of the streams. The pipe should be of three-quarter inch size to assure a free flow, except the central or "trunk" pipe, which should be 2 inches. Four pipes, quartering the circle, should be joined to the center or vertical feed pipe.

The excavation for the ground basin should be made below the frost line and provision made for draining the fountain by laying pipes that will carry the water off through an overflow vent. A foundation of crushed stone or gravel should be laid and after this has been watered the concrete can be laid, leaving a hole in the center for the pipe. A circle may be drawn with the pipe hole as a center, and the work of laying the concrete should be carried on with this as the working point. The concrete, one part Portland cement, three of sand and five of gravel should be well tamped.

When the concrete has dried sufficiently to allow the work to proceed, attach the pipe system and place a circular form for the first section of the central column, tapering up slightly and about 12 inches in diameter at the bottom. Fill with concrete and tamp in layers of four inches. Place a saucer-shaped form far enough below the pipes of the middle basin so that they will be in the center when the concrete is filled in. This form should be

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about two inches more in diameter than the circle of pipe. Fill with concrete, trowel thoroughly and proceed with the second section of the central column and top basin in the same manner.

The forms should not be removed for at least two weeks, at the end of which time they may be taken away and the fountain given a finishing coat of water proofed mortar.

The forms for the basins will be best made of 2x6s, each piece sawed out so as to give an approximate saucer shape when all are nailed together. Then the finish of

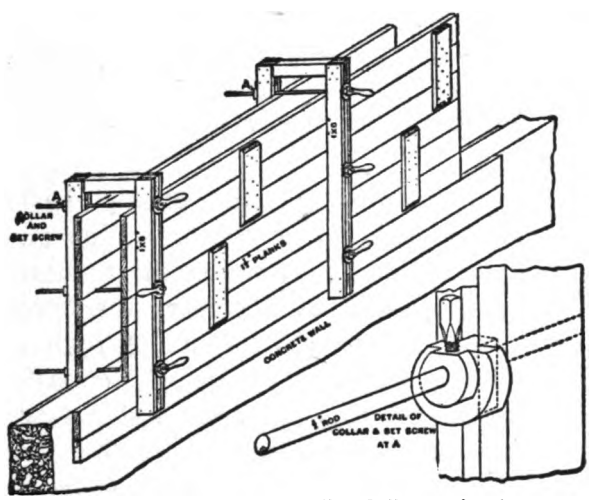

Fig. 9—Suggestion for barn wall. Collar and set screw method of holding wall forms in position.

the form may be done with a chisel. Ingeniousness will find it possible to give the edges of the basins artistic effects in the finishing.

Greenhouses. The concrete greenhouse offers the special advantage of being more easily heated than wooden ones. Greenhouses of this construction also keep out the cold air and protect the growing plants against sudden changes of temperature. The greenhouse foundation should be ten inches wide and sixteen inches deep. The mixture should be one part Portland cement, three parts sand and six parts crushed stone or gravel. On this and at equal distance from each edge a wall seven inches thick should be built. The mixture for this should be one part Portland cement, two and one-half parts sand and five parts cinders. The wall should be carried up to the height desired and a ridge pole erected six inches wide and eight inches deep, with one part Portland cement, two and one-half parts sand and five parts crushed stone or gravel not more than three-quarters of an inch in size. This pole should be reinforced with two steel bars half an inch in diameter. If the total width of the house is not over 16 feet, beams from the ridge pole to the side walls 2 1-2 inches by 5 inches, reinforced with a half-inch bar, will be strong enough. For the support of the ridge pole, posts eight inches square should be placed at intervals of ten feet. The final or finishing dress for all the concrete should be a quarter-inch coat of cement mortar.

Frames for Hot Beds. The hot bed is so small in size that no reinforcement is necessary in its walls. Forms are made of the desired size with a provision for a slant and allowing for three-inch walls. The concrete should consist of one part Portland cement, three of sand and six of stone or gravel that will pass a half-inch sieve. On the upper edge and about the interior may be imbedded strips for use when the glass frames are placed on top.

Concrete Ice House. The modern equipment of a rural home, especially if it is located where a supply of ice is available for harvest in the winter, is not complete without an ice house. And to this purpose no material lends itself better to the construction than does concrete. To be sure that the heat will be kept out in the summer, it is well to provide for a wall at least sixteen inches in thickness. A wall of this character will protect the contents of the ice house amply. For a house of ordinary size, sufficient to hold

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a supply for a family of five or six, an excavation one foot below the desired depth will do. This surface should be cleaned off and leveled and upon it a layer of crushed stone or broken bricks should be placed, ramming the material thoroughly. This will afford opportunity for drainage. If the wall is to be of sixteen inches thickness, the forms should be set up allowing for a space of that width. The foundation, on the sub-foundation that has been previously wetted, should be composed of a mixture of one part Portland cement, three parts clean, sharp sand, and six parts of broken stone. The foundation ought to be four feet deep. Better satisfaction will be secured if provision is made for an air space between the walls. Two 6-inch walls 4 inches apart and bound together with rods will be a good arrangement. Separate forms for each must be constructed. Walls of this width will require no other reinforcement than the binding rods, provided the house is not to be high. One part of Portland cement, two of sand and four of crushed stone will be the proportions of the mixture for the walls. The walls should be built in sections about two feet high at a time. Place the rods of half-inch iron with strong heads imbedded about two inches in the inner surface of each wall and about a foot apart. This will help the wall stand the lateral pressure of any pile of ice within that may rest against it. The roof, reinforced with ¾-inch iron rods a foot apart, is the next step. A form is constructed of the desired angle. Upon this about three inches of sand is placed and smoothed off carefully. Lay the rods so that they will rest one and one-half inches above the sand and put on a coat of three inches of concrete. The forms should not be touched for two weeks. Then the sand can be let out from the interior. All the openings between the walls and the roof must be closed up.

Storage Buildings. They should be built of hollow concrete blocks, and if monolithic in form, there should be an air space in the walls. The air space is necessary to retard dampness and keep out the frost.

Root Cellar. Cellars of this character usually are built half below and half above the surface of the ground. When properly made they ought to be proof against all inroads by frost. Excavation should be carried down to a point sixteen inches below the desired level of the floor. The foundation should be twelve inches wide and the mixture for it should be one part Portland cement, three parts coarse sand and six parts crushed stone or gravel. Forms should be made for the foundation. After it is laid, the forms should be removed and a porous material, either broken bricks or cinders, should be filled in over the floor space to a depth of twelve inches. This should be well tamped. The floor, of a total thickness of four inches, should consist of three inches of concrete and one inch of cement mortar. The concrete should be one part cement, three parts sand and five parts crushed stone or gravel.

The wall of the cellar should be eight inches thick, started from the center of the twelve-inch foundation. The mixture for the wall may be one part Portland cement, two and one-half parts sand and five parts crushed stone, gravel or cinders. Build up the end walls so as to form a point at the middle and high enough to give the roof a sufficient pitch to shed the rain. Near the top at each end it should be remembered to provide openings for windows, and the sash should be fitted and plastered in after the concrete has set and forms have been removed. Bins should be built of a size to suit convenience with walls four inches thick and reinforced with

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one quarter inch rods placed twelve inches apart horizontally and vertically to give the bin walls strength to withstand the lateral pressure when they are filled with vegetables.

If a concrete roof is desired, forms should be erected and a roof two and one-half inches thick built. On the top, and before the concrete is dry, a quarter inch layer of mortar, consisting of one part Portland cement and one part sand, should be placed and well troweled. The forms should not be removed before three weeks. The roof should be reinforced with woven wire fabric and so should the steps. If the roof is sufficiently long to require supports, an eight-inch pillar in the center may be erected, reinforced with one-half inch rods two inches apart and one inch from the surface.

Mushroom Cellar. The method of constructing a cellar of this character is the same as for a root cellar, with the exception that no floor will be required and there should be little light.

Concrete Fence Posts. The index of a farmer's thrift is his fences. Nothing adds so much to the appearance of a farm as a neat, well kept fence, and nothing detracts so much from it as one broken down or in bad repair.

The concrete fence post is one that will not have to be replaced, for it does not rot. It should be 6½ feet long, 6 inches square at the bottom and taper to four inches at the top. Good forms are on the market, but if a homemade form is desired, make two forms for the post of surfaced boards six inches wide at the bottom and four at the top. To make them stiff so that they will not crowd out in tamping the concrete into them, nail a strip 1½x4 inches, and 4½ feet long on the outside of the form to reinforce it, driving the nails from the inside through into the strip. This, while light to handle, will keep the form true. Take a board 6 inches wide and into it saw and cut grooves at right angles with the edge of the board 6 inches apart and fitting over the bottom end of the side forms. Take a board 4 inches wide and do the same for the top and so that when the form is together, the space on the inside will measure 4x4 at the top and 6x6 at the bottom. The ends can be held in place by wood screws. Lay the form on a dressed board eight inches wide and seven feet long, on which it can remain till the concrete is seasoned. This board should be placed on the ground so there will be no jarring during the tamping. The concrete should be a mixture of one part Portland cement, 2 of sharp sand and 4 of crushed stone or gravel that will pass a 1-3-inch mesh. Tamp the concrete one inch at a time. Place 2 crimped wires about one inch in from the outer edge and parallel with the edge. This will bring them about 2 inches apart at the top and 4 at the bottom. The first wires should be placed after the first inch of concrete is tamped. Fill to within one inch of the top and place two more wires. Twisted wrought iron rods ½x¼ inches may be used instead of the wire if desired, one rod serving the purpose in each post.

Where it is desired to spike or nail to a post a pail block or a strip is bolted to the top for the purpose. In making the post, set an iron pin ⅜-inch thick into a a hole bored into the pallet at the proper place, say six inches from the top of the post and exactly in the middle. Three feet from the top set another pin in the pallet in the same way. Mold the post around these pins. When through and before removing the form, slightly tap them with the hands to loosen and then pull them from the post. Through these holes ¼-inch bolts will pass into the nail strip, holding it into place. This post can be set to nail

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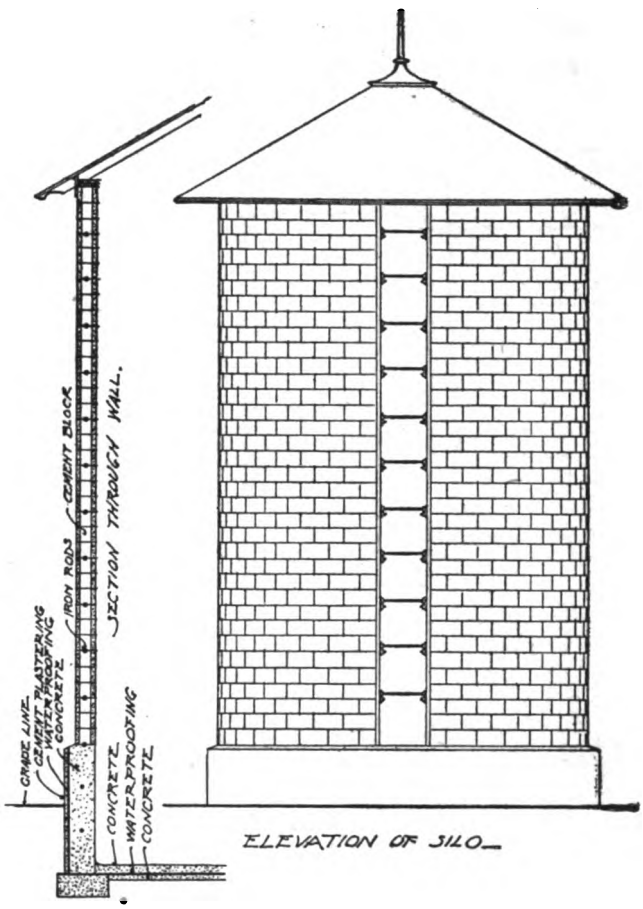
into the broad part of the 2x4, or set so that the nailing is attached to the edge.

When it is desired to attach wire to the posts, bore holes at the proper places into the pallets to correspond to the spaces of the wire and in the middle of the post. Into these set ¼-inch pins and build around them, removing them when done. Through these holes the wire can be stretched.

Building Concrete Silo. The silo has come to be one of the necessary parts of the farm equipment and it is unquestioned that concrete is the ideal material for its construction, for concrete makes the silo air tight and too heavy to blow over and it will last for ages. The concrete silo can be built at low cost, provided the walls are not made too thick. By using reinforced concrete, the thickness of the walls can be reduced to a minimum. Silos in cold climates are best built with a hollow wall. The specifications for one of this character are:

Excavate to a depth below the frost line and of the desired diameter, allowing for the thickness of the walls. Erect a sixteen inch solid wall to the level of the ground with concrete, one part Portland cement, two and one-half parts clean, coarse sand and five parts broken stone. After removing forms, fill the excavation inside the walls to within 8 inches of the ground level with cinders, gravel or broken stone and tamp hard. Pick with a stone axe that part of the inside wall that shows above the porous foundation and wet thoroughly. Fill the space on top of the cinders, etc., with concrete to within one inch of the foundation. Erect forms four feet high for three-inch hollow core walls with ten-inch air chamber.

In a circular form there are two sides, the inner and the outer. These are made in the same way, but cannot be of the same pattern, as the thickness of the walls comes between the two parts, making the radius of the sides different. The simplest way to make a circular form is to draw a circle of the size of the form desired and lay boards around the circumference of the circle. These boards should be lightly tacked together in place, and, using the



same measure, mark the circle on them. They should then be knocked apart and sawed out along the lines marked, the pieces then being fastened securely together. After making two or more circular forms, place them at equal distances apart and put on the side boards.

Silo of Concrete Blocks. The method used for the construction of a silo of this character is as follows: Place five eight-inch rods with turn-buckles every four or

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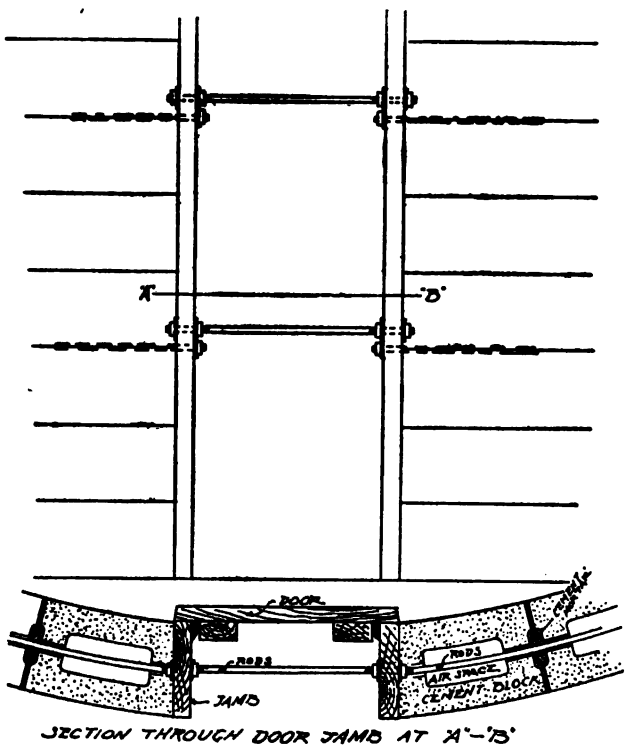
five feet, the ends being down in the hollow block sufficiently to hold while tightening the turn-buckle. The lap or tie rods used around the entire circle at the same course of blocks are made of half-inch rods. The jamb at the opening is made of 2x12 wood, with a 1x4 board setting into the recess of the block to prevent slipping, and two stops on the opening side for a sliding plank. A casing board on the inside is only required when the blocks have



SECTION THROUGH DOOR JAMB AT A'-B'

no recess. It may prove cheaper to build a silo of 2x6 studding, 16-inch centers, with metal lath and stucco plaster on both side and interior.

Wind Mill Foundation. The most frequent complaint against wooden foundations for wind mills is concerning the habit they have of rotting. Concrete construction will overcome this and give to the wind mill a solid foundation that will insure it against being blown over in storms.

Ecavate four holes at the desired distance apart, 2½ feet square and 5 feet deep. Build forms for the sides and grease them properly. Fill the forms 2 feet deep with concrete, one part cement, three parts sand and six parts of broken stone or gravel, of a jelly-like consistency, tamping well every four inches.

The holding down bolts can be suspended from a frame over the top, care being taken to place them so that they will be in true position when the concrete is placed around them. They should be two feet long with plates to resist the pulling strain. Fill the form with concrete flush with the top and allow it to remain for several days before using. This will make a substantial anchorage for a steel tower. If a wooden tower is to be used, run projecting bolts up through the timber sills and use large cast iron washers under the bolts. The anchorage in this case should project at least 6 inches above the ground.

Poultry House of Concrete Blocks. The following is a plan for a poultry house. The front is 6 feet high and the rear 4½ feet. The ground space is 8x16 feet. A partition is built 6 feet from the front, leaving an 8x10 scratching shed. This shed has an open front three feet high, with a wire netting stretched across and a curtain to drop in rough weather. The roof is made of cement mortar, but not in the ordinary way. The rafters are 2x4 set to 16 inch centers. The roof is lathed with strips 1x2 inches set ¼ of an inch apart. The mixture for the roof is the same as for cement mortar, one part Portland cement and two parts sand. Strips should be nailed around the edge of the roof extending five-eighths of an inch above the edge as a straightedge for the finishing. The cement should be troweled down smooth. The roof made in this manner has proven eminently satisfactory in every case.

Another plan provides that a trench 12

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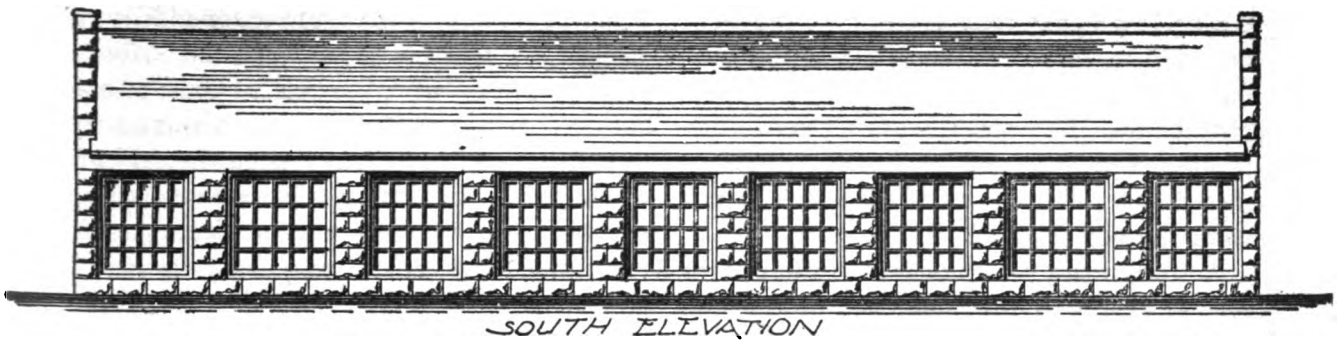
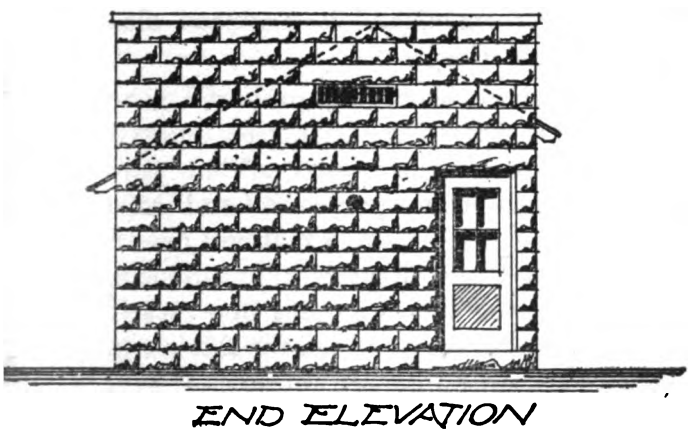


Poultry house of blocks.

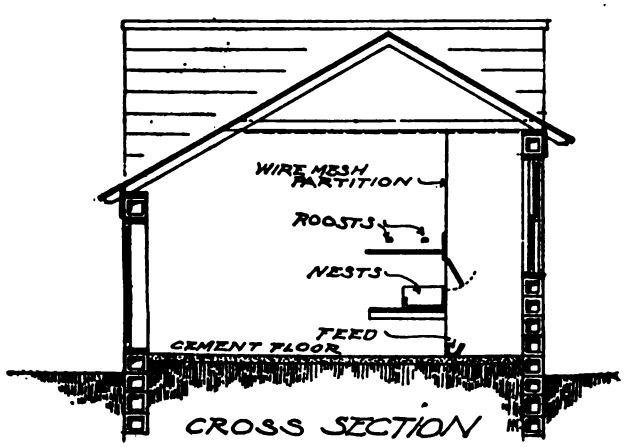
inches wide should be dug below the frost line. Fill it with concrete consisting of one part cement, three of sand and six parts crushed stone or gravel. The walls of the chicken house, which should be reinforced



with ½ inch iron rods a foot apart, should be five inches thick. For these forms will be necessary, allowances being made for the windows which should be on the south side of the little structure. The roof may be made with one slat and of reinforced slabs of a 1-3-5 mixture with wire netting reinforcement. The concrete for the walls should be of one part cement, three parts sand and five parts gravel or crushed stone that will pass a half inch mesh.

A concrete poultry house will be found to prevent lice in chickens more readily than a wooden structure that has to be whitewashed frequently, besides being warmer in the winter and thus encouraging hens to lay when eggs are at their highest.

Hog Pens. Usually about the farm the most difficulty in the matter of cleanliness about the buildings is encountered in connection with the care of the hog pens. By the use of concrete whose surface lends itself readily to flushing with water, much of this trouble is avoided. The size and the shape of the pen having been decided upon trenches for the foundation should be excavated a foot wide and below the



frost line. On this a foundation consisting of one part Portland cement, three parts sand and six parts gravel or crushed stone, should be laid. Four parts of gravel or crushed stone or gravel is used in the mixture for the wall instead of six that were in the foundation. The floor of the pen is made in the same manner as followed in the laying of concrete walks.

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The hog house may be built in one corner of the pen and its walls should be four inches thick, with a reinforced one slant roof of 2½ inch concrete reinforced with netting and rods of half inch thickness placed ten inches apart, if the house is not more than 10x12 feet.

A trough can be made by the use of two forms, one of a long box shape and the other shaped like a V for the trough cast. First provide a smooth surface or platform to lay the forms on. Place first the V form in the position of a pyramid. Over it set the box, being careful that the adjustment is arranged so the V form is in the middle of the box. Fill with a mixture consisting of one part Portland cement, three parts sand and five parts gravel or crushed stone. Do not disturb the forms for three or four weeks.

PART XII.

Concrete Tanks and Cisterns.

Concrete Tanks. It is unquestioned that a tank built of concrete is not only more durable than one of wood, but is more sanitary. Many farmers have them installed in their barns, and tanks of this character answer the requirements in numerous manufacturing plants. Two forms are required in the construction of a tank. One is needed for the molding of the exterior and a smaller one for the formation of the inner surface of the walls. Each form should be made of dressed boards without knots that will disfigure the surface of the concrete. For a tank of medium size, say 2 feet wide, 6 feet long and 2 feet deep, the walls should be three inches thick. Allowance must be made therefore in the making of the two forms for a space of this width.

A flat surface perfectly smooth should be provided on which to place the forms. The smaller one is put in position first, as it is the one that will form the interior walls. It would be well before placing the larger form to measure carefully for the placing of it by laying it on the platform over the smaller one and marking the corners, fastening the form so that it will not move when the concrete is placed. The inner form should be fastened also for the same reason.

The concrete should be prepared near at hand so that it can be placed quickly. The mixture should consist of one part Portland cement, two parts sand and three of gravel or crushed stone that will pass a quarter inch sieve. Be careful not to make the mixture too wet. Tamping in layers of three inches is recommended for this work, each layer being followed up quickly with the succeeding one so that the fixing may be uniform. The top is last leveled off and finished. Do not disturb the forms for a week or ten days. Then they may be removed and the drying continued.

Waterproof Concrete Tank. The suggestion is made that in all cases the water tank should if possible be slightly flaring so that if the water in it freezes the pressure of the expanding ice will be less than if the sides or ends are vertical. The point of this suggestion will be evident to the reader. In the case of water troughs this shape is more desirable from a utilitarian point of view, as it affords easier access. The first factor to consider is that of strength. The waterproofing of the tank can be attended to later. The best mixture

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for a tank is one part Portland cement, three parts of sharp sand and five parts of gravel mixed with sufficient water to make the cement plastic or "sticky," but not thin enough to pour.

First dig the foundations and place the footings for the wall and floor. Then mix the concrete as follows: For the foundation up to within four inches of the floor line use one part Portland cement, three parts sharp sand and two parts gravel that will pass through a one-inch sieve and four parts gravel that will pass a two inch sieve. Mix thoroughly and ram into position. If the tank is to be as large as 30x40 and 6 feet high this course should be covered with a three and a half inch course of one part Portland cement, three parts sand and three parts gravel that will pass through a sieve of ¾ inch mesh. After this has hardened sufficiently build the false work with a plank on both sides and put in all pipe connections before beginning to place the concrete for the walls, as any interference with the foundation after the walls are erected is not an easy matter to remedy. Mix one part Portland cement, three parts sharp sand and five parts clean gravel that will pass a one inch sieve and just enough water to make it sticky, and ram hard into position. Leave all the false work in position for at least three days to allow the concrete to harden. After removing the plank plaster the exterior surface with a mixture of one part Portland cement and two parts sharp sand that has passed through a screen of sixteen meshes to the square inch. This will give a finished effect and will hold if the surface is wetted before application. A waterproofing compound should be used in all the mixtures.

Building a Concrete Cistern. The mixture for a cistern should be made of one part cement and three parts sharp sand. The two should be mixed dry and water sufficient to make a stiff mortar should be added. If the soil is of such a character, as clay, that there will be no danger of a cave in it is not necessary to wall up with brick. The mortar should be applied about one-half inch thick and should be followed immediately with a second coat one-fourth of an inch thick. Then give a skim coat made of equal parts of cement and sand. Keep the surface moist a week and do not fill with water until 10 or 12 days. Cisterns made in this manner are usually built egg-shaped, with the use of false work for crowning the top, in which case the skim coat cannot be added. The walls in egg-shaped cisterns should be two inches thick at the bottom, three-quarters of an inch on the side and three inches on the crown. If there is to be more than the ordinary pressure on the crown it can be reinforced with wire netting. Local conditions must favor this method. It will not answer in all cases. A four-inch brick wall laid in cement mortar (one part cement and two parts sand), and plastered on the inside a half inch thick with the same mortar, waterproofed, is in most cases satisfactory. But to make the cistern absolutely water tight let the wall become hard, which requires six or eight days.

Concrete Well Curbs. For cleanliness and sanitation, so essential in a well, concrete possesses advantages over brick or stone, especially if the surface down to the water line is made waterproof to keep out any possible seepage of surface water. A method that is recommended for the building of well curbs is here given that is applicable to almost all cases. The excavation having been carried down to water, the sides of the well made smooth and made ready for the concrete, a form ten inches less in diameter than the well excavation should be made of planks nailed securely and vertically to the frame. This form should be at least two feet in height and

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may be higher, but a two-foot form will be handled more easily.

Operations should commence at the bottom of the well, where the form is first placed. The mixture for the concrete should consist of one part Portland cement, three parts coarse and sharp sand and five parts of broken stone or gravel. A waterproofing also should be used. Placing the form in the center so that a five-inch margin will remain around the circumference for the concrete, begin filling in, tamping every four inches. When the form is filled nearly to the top allow the concrete to set and raise the form carefully for the next section, being careful to have it at all times plumb. This operation is repeated with the filling in till the top of the well is reached. The concrete should be laid five or six inches above the surface of the ground to keep out all surface water. As the work of filling in progresses staging of planks can be built to provide working room. After the concrete is dried these can be taken out.

PART XIII.

Roofs, Chimneys, Etc.

Concrete Roofs. It will be impossible to build a concrete roof that will not crack unless the walls are rightly constructed and on a foundation that will not settle. Roofs require special care to render them water tight. Sinking of the brick work on new structures often is the cause of cracks in a concrete roof. Of course a crack in a roof of this material is more serious than in any other work, as it means a leaky building. The rough coat should be laid and solidly rammed and compressed. So far as possible the top coat should be laid in one piece. Roofs exposed to the sun should be kept damp for a number of days after being laid, as they are easily affected by the heat. Expansion may be counteracted by the use of strips around the walls. A skirting six inches high and one inch thick should be keyed to the walls. A good top coating is made with one part Portland cement, one-half part of slacked lime and one part of fire brick dust.

Cement Brick for Chimneys. Concrete blocks and Cement brick make desirable chimneys, and if care is used in the construction entire satisfaction ought to be attained. Dry concrete being fireproof to the extent of its raw material it has been found that sand usually endures more heat than cement. It is therefore necessary to select a cement that has been highly burned, no less than 1,200 degrees, which will make a chimney safe. But the chimney may discolor at 800 degrees without injury. For wood and soft coal fires Portland cement is acceptable: for hard coal and coke the cement must be selected and gravel, limestone and soft sandstone must be omitted. The inside of the chimney should be plastered with mortar made of one part cement to three parts of sand mixed with strong salt water.

Chimney Caps. Among the many uses to which concrete may be put to advantage is in the making of chimney caps. In many localities they are supplanting stone, brick and iron. The operator should provide himself with a box having no bottom and having interior measurements the size of the desired cap. One or two smaller

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boxes to act as forms for the flue or flues, as the case may be, should be one inch higher than the large box, to provide for slope from the edges of the flues to the edge of the cap. About four inches is the ordinary thickness for a cap, so that the flue forms should be five inches. Plaster the inside surface of the big mold with one-half an inch of stiff mortar and immediately fill the form to half its capacity with one part cement, three parts sand, and six parts broken stone. Then put in the reinforcing, which should be woven wire, expanded metal, or ¼-inch rods. Then complete the filling, tamp until the water puddles up, and when the mixture is partly set trowel smooth.

In the event that it is desired to build

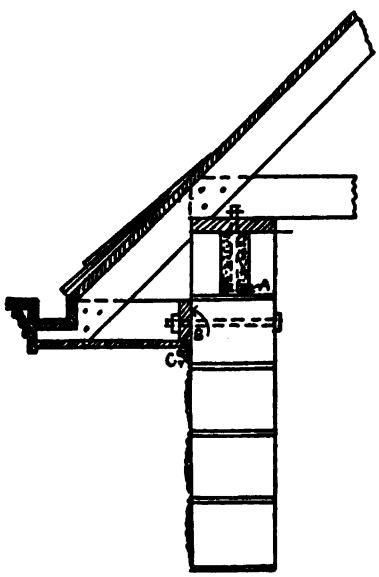

Fig. 8—Method of joining the roof and the block course.

the cap in place, small rods should be placed across the chimney between the flues. On these build a platform of tongued and grooved boards planed on the upper side, and driven snugly together but not nailed. On this platform place the forms previously described and fill with concrete reinforced. After the concrete has set for a week remove the platform by raising each side of the chimney cap alternately and knocking the platform apart. Remove the outer and inner forms. Raise one end of the slab, cover all the top of the chimney that can be reached with mortar, lower the cap on the bed thus formed and remove the rods under the end. Repeat the process at the other end.

Fireplace of Concrete. A special formula for the blocks used in the construction of a fireplace is necessary to guard against discolorations from the heat. Blocks made in the following proportions will prove satisfactory for the fireplace and chimney construction: One part Portland cement burned at 900 degrees or more, one part fine sand, three parts coarse sand. Blocks must be well tamped and kept moist for a week. After the blocks are laid cover all surfaces exposed to the fire with a solution of one-half pound of soap, one pound of slacked lime, applied with a flat brush. This solution will fill the pores and prevent discoloration.

Concrete for Hearths. The ordinary method of construction for work of this kind is to build a brick arch for the foundation, upon which the concrete is placed. This insures perfect fire protection. The top may be dressed with a trowel or it may be finished with tile, as some prefer. The concrete for a hearth should consist of one part Portland cement, three parts sand and five parts crushed stone or gravel, all thoroughly mixed.

Concrete Sinks. Sinks made of concrete are considered as durable as iron. They may be made in any desired size and reinforced with wire netting. They are cast in wood or plaster molds. The mixture should be one part Portland cement and two parts fine crushed granite. A rebated hole should be provided for a trap. The thickness should be two to three inches.

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PART XIV.

An Ideal Concrete. A mixture of cement mortar (1 part cement and 2 of sand) and gravel or crushed stone is commonly called concrete. An ideal concrete would be one in which all the voids of the aggregate were filled by sand and all the voids of the sand filled by cement. This would mean a perfectly compact mass. In the proportioning of the materials it is better to measure by weight than by volume. The aggregate should be clean and free of every impurity and the sand used should be flinty and sharp angled whenever obtainable. It is more important, however, that the aggregates should be sharp angled as they will hold in the mass better. For very strong concrete one part of cement, two of sand and four of aggregate are recommended. For work of medium strength one part of cement, two and one-half sand and five of aggregate is the rule, and for work where little strength is required one of cement, three of sand and six of aggregate is sufficient.

Artificial Marble Molds. In making artificial marble in molds there is a departure from the dry tamp process, unless iron molds are used, but where only one or two pieces of each design are required the cost of special iron molds would bar their use.

Make a wood pattern exactly like the article desired and a flask for it the same as is done in any iron foundry. Fill the mold in the same way, only that one pound of plaster of paris to every twelve pounds of sand is used. This composition is dampened and rammed into the mold. After it has been carefully filled and the wood pattern removed, let it stand for a day, then coat the interior with a heavy lacquer to insure a smooth finish. Close the mold and fill with a composition consisting of one part Portland cement, one part marble dust and two parts fine, sharp sand, all to be mixed with sufficient water to admit of pouring. Keep the mixture agitated till it is poured. Do not open the mold till the cement has set at least twenty-four hours. Then keep it damp for four or five days. To polish, let the cast dry for a week or ten days more, when brisk rubbing with dry felt, adding dampened oxalic acid occasionally, will produce a luster equal to that of any natural marble.

Openings in the form for pouring must be made at all high places and before removing the pattern it is well to penetrate the molding sand with a steel wire, thus allowing a free escape of the air in the cavity, and thereby preventing honeycombs.

Some experience is necessary to make this process a success and by careful usage the same mold can be used several times. Crushed lime stone can be substituted for the sand, but it will produce whiter, though less durable work. Almost any color can be produced by adding the pigment to the composition in the dry state.

Causes of Failure. The chief causes of failure in concrete work are the use of too much water and imperfect mixing. If the operator would bear in mind that the purpose in making concrete is to imitate as nearly as possible the solid rock he would succeed better. Properly made, concrete is as strong as the best stone that comes from the quarries. Every authority who knows anything about cement urges the importance of thorough mixing and the judicious use of water. It has been demonstrated that the best results are secured by the use of aggregates of varying sizes, as the voids are less in quantity and the mass consequently more nearly approaches rock in its consistency.

Freezing. Concrete work should be

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avoided as far as possible in cold weather, as the frost will prevent the binding of different layers and will cause a thin surface to peel off on the surface of the concrete. Salt is used frequently to lower the freezing point of the concrete. One method is to add one per cent, by weight, of salt to water used for each degree of Fahrenheit below freezing. It is impossible to tell, of course, how low the temperature is going, so it has been adopted as a practice to add ten per cent by weight of salt to water or its equivalent. This method, however, is questioned by some. Another and perhaps preferable method is to mix warm sand and stone with the cement and water in such a manner as will bring the entire mixture up to about 75 degrees, protecting in the early stages of setting, so far as possible, from cold and currents of air.

Effect of Lye. One example showing the effect of potash on concrete is given in connection with its use in a soap factory where it was discovered that lye water made a harder concrete in much less time than pure water. The lye water was used in laying several hundred feet of concrete flooring. The floor wore well for two years, when the crumbling commenced. The daily sweepings consisted largely of concrete and in a short time the four inches of concrete was entirely swept away in spots.

Influence of Tamping on Strength of Concrete. Some tests carried on under the direction of the German Concrete Association give a fairly clear indication of the influence of tamping on the strength of concrete. The tests were conducted at three different places with the same class of material and in accordance with the same conditions. Concrete cubes of 12 inches were formed under 6, 12 and 18 blows from a 26 pound hammer falling freely from a height of 10 inches. The cubes were molded in two layers, and after the first layer had been tamped in the mold its upper surface was roughened to secure a satisfactory tooth for the second layer, which was then tamped on. After remaining for forty hours in the mold the blocks were stored in wet sand for twenty-eight days and tested under compression in the direction of tamping. Two different percentages of water were adopted and some of the concrete was mixed by hand and some by machine. The tabulated collection of results shows that the compressive strength of dry concrete mixtures was increased from 12.4 per cent to 22.2 per cent, and that in the case of plastic mixtures the increase varied between 3.2 per cent and 18.6 per cent. The figures indicate also that beyond a certain number of blows the tamping causes a gradually decreasing augmentation of strength and finally leads to diminution of the augmented strength. The results show also the superiority of machine-mixed over hand-mixed concrete.

Ramming Concrete. The purpose of this process is to make the mass compact and to bring as closely together as possible the elements in it. The ramming decreases the voids and forces out the surplus water. Without this compression it is impossible to secure impervious concrete. Care should be taken, however, not to ram too much, as the process, if continued after the cement is set, will result in a loss of strength. Where the work requires that the aggregates be deposited in layers, no layer should be less than four inches deep and each layer should be deposited upon the one already rammed in time so that the two may be joined by ramming.

Troweling Concrete. The proper motion for this operation is a circular or ironing motion with the flat of the blade that will gently compress the material and make it smooth. In working with the trowel the operator will have to reach far out probably on the surface, and for this

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purpose he should have a hand float to lean upon. Much care is necessary in making a good job of troweling and the best results are attained only by patient

Piers and Posts. For this work the builder should excavate below the frost line and build forms 2 feet square to a point within 6 inches of the surface of the ground. Fill with concrete consisting of one part cement, two and a half parts clean, sharp sand, and five parts crushed stone or gravel not more than one inch in size. The mixture must be tamped carefully. From the center of this foundation, build a hollow form one foot square and to the desired height, and fill with concrete of the same composition as the other. Before the form is filled, and in fact before it is set, place four steel bars ¾-inch in diameter vertically so that they will be about two inches inside the corners, and around them, at intervals of one foot, wind loops of ⅛ or ¼-inch wire, tying them to the steel rods with finer wire. Every two feet a short piece of ½ or 1-3-inch wire may be tied to each of the vertical rods so as to project against the form and hold the steel in place. The concrete should be made soft and pliable so that it will flow, and, as it is poured into the top of the mold, work a long paddle made like the oar of a row boat, against the forms to force the stones away from the surface and drive out bubbles or air which tend to adhere to the forms and form pockets of stone. This method of construction makes an excellent foundation for a barn.

Rubble Stone and Its Use. Sometimes a saving of expense may be secured in the construction of massive walls or abutments by the introduction of large stones into the mass. When this is done the stones should be used only in the middle or center of the wall and each one should be so placed that there will be ample room between it and its neighbor. Thorough tamping about the stone is necessary to insure the cement adhering to its surface. Stones used in this way are better if their surface is irregular than if they are smooth or rounded, as the voids of the irregular stone afford better holding power for the cement.

Gauging Concrete. It is in this part of the work that haphazard methods are apt to creep in, especially if the operations are hurried. The importance of accurate measuring and strict adherence to proportions cannot be urged too strongly. For ordinary handwork not more than a cubic yard should be gauged at a time. The worker should have plenty of space for handling the mixture. Faulty concrete is made more often by carelessness in gauging than from any other cause, but the blame usually is ascribed to something else. It should not be permissible to measure the cement by so many sacks or the aggregate by so many barrow loads. Accurate measure should be maintained so that the chances of poor concrete will be avoided. The aggregate and the cement should be turned over at least three times on the board and when it comes to adding water it should be applied gradually, all the time being mixed. No more material should be gauged than can be handled quickly. As soon as the concrete is ready it should be shoveled into pails and carried to the place where it is to be used. Nor should there be any disturbance of it after it is mixed more than is absolutely necessary, for this destroys the setting properties of the cement.

One Cubic Yard of Concrete. Its Parts. The following table shows the amount of materials in a cubic yard of concrete, the figures in the first column being for cement, sand and gravel or stone:

1:2:4	1.57	3.14	6.28
1:2½:5	1.29	3.23	6.45
1:3:6	1.10	3.30	6.60
1:4:8	0.85	3.40	6.80

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Decoration With Colored Clays. This process which comes more properly in the realm of art than of architecture, has received much attention and study by Henry C. Mercer, who in a paper read before the American Portland Cement Manufacturers, explained the process. He said:

"When I found the facility with which permanent weatherproof color could be burned into clay, and realized the tensile strength of the recently improved cement more or less reinforced with iron, I saw how large clay pictures or mosaics could be made, not in the old Roman way or other previously known ways, by building up the design with minute tesseræ, but by boldly cutting it out of slabs of colored clay. Burn the latter, reassemble the burnt pieces as you would the units of a stained glass window, drop them into a bed of cement and you have a mosaic.

"Because the process lent itself to bold designs on a large scale, and because of the fire and weatherproof character of cement and clay, the method particularly adapted to the decoration of pavements and the inner or outer walls of brick, stone or cement buildings.

"Patterns ranging from one foot to twenty feet in diameter, or even where the figures of men or animals might equal life-size, consist of clay burned in many colors superficially or throughout the body, and either glazed or unglazed. The tesseræ, not rectangular as in Roman or Byzantine mosaics, but cut in multiform shapes to suit the potter's process, and whose contours themselves help to delineate the design, are set in cement at the pottery. Just as in the leaded glass designs of the stained glass window, bands of lead holding together the glass units form the pattern, so here the cement remaining visible around the circumference of each piece presents the outline of the picture. Thus you have a picture drawn in outlines of cement with clay colors set between the latter. I paint my pattern with clay paint, but I draw my outlines with your cement.

"Consider your cement, then, from two points of view as I apply it, first artistically, and second, practically, to my decorative work. For whether I insert my mosaics into a brick wall or wall of concrete, my drawing is done in cement and produces its effect, over and above my abilities to draw; first, by the color of these outlines, and next by their size and shape. From my point of view the complained of gray of cement is not a misfortune, but a favor. In its neutral color it tones with any hue. So, as far as the outlines are concerned it can often be let alone. I have tried to color it for red, blue, green, yellow or white outlines, but finding that all are more or less artistically injurious or restless, I have preferred to stain these outlines in the black that old wood cuts have guaranteed, or let the gray or gray-white of the cement produce its own effect."

As to the minimum thickness of the walls of a block the opinion is that two inches makes a block strong enough. The thinner the walls of a block are the less load they will have to carry necessarily.

Concrete Graves. It has been the practice many years in the larger cemeteries to build concrete graves. They should be made the day before the casket is to be deposited so that the cement will be set when interment takes place. The walls usually are three inches thick and the top is a concrete slab that fits over the walls.

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Estimated Cost of Houses

It is impossible for anyone to estimate the cost of a building and have the figure hold good in all sections of the country. We do not claim to be able to do it. The estimated cost of the houses we illustrate is based on the most favorable conditions in all respects and includes everything but the plumbing and heating. We are not familiar with your local conditions, and, should we claim to know the exact cost of a building in your locality, a child would know that our statement was false.

The houses shown on these pages are modern and are the best that the highest architectural skill was able to produce. Every requirement is taken into consideration. Economy in the use of material also was kept constantly in mind.

If after looking over these pages you see a house that pleases you the best this Company can say is to consult your responsible Building Material Dealer and Contractor, for they alone know your local conditions. You know them as friends or neighbors, and you can better depend on them than any one else to give you the correct figures. You doubtless are aware that there are seasons of the year when you will be able to build a house for from ten to fifteen per cent less than at other times on account of the fluctuations in the price of labor and also because of the fluctuation in the price of building material due to natural economic conditions.

Every one who has done any building has given much attention to the consideration of cost, and this Company has come to the conclusion that the only reliable way to arrive at a satisfactory estimate is to pursue the method we advise, for the responsible Building Material Dealer and the responsible Contractor in any given locality should be consulted in all cases, as they are thoroughly conversant with every condition and constantly in touch with every factor governing building in their neighborhood.

Our Guarantee

If, upon receipt of the plans you do not find them exactly as represented, if you do not think them complete and accurate in every respect, if you do not find them as accurate and as well prepared as those furnished by any architect in the world, or any that you have seen, we will immediately refund your money upon return of the plans in good condition. We make this guarantee with the full assurance to you that you run no risk whatever, and are moved to make the guarantee strong as we can make it to disabuse the mind of any person who may have the idea that the plans are a cheap variety on account of their very low price. All of the plans we furnish have been prepared by licensed architects of high standing in their profession who have given years to the study of the requirements of American home builders.

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PART XV.

Perspectives and Floor Plans

—of—

Cement Plaster and Concrete Block Houses

NOTE THE VERY LOW PRICE AT WHICH THE COMPLETE WORKING PLANS AND TYPEWRITTEN SPECIFICATIONS FOR ANY OF THE HOUSES ILLUSTRATED IN THIS BOOK CAN BE SECURED. WE MAIL PLANS AND SPECIFICATIONS THE SAME DAY ORDER IS RECEIVED.

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PART XV.

Cement House Plans.

If you have studied the preceding pages one thing has been impressed upon your mind more than anything else—the imperishability of a house made of cement. You now know the wisdom of building a home that will defy the elements and time. You know how to select your materials and how to proceed. As the building of a home is the ultimate ambition of the average man and the climax of his hope, so do we deem it a fitting climax of this book to lay before you a collection of cement house designs for your further delight and study. It is a pleasure to tell you that this is the first complete and comprehensive display of cement house designs and how to build them that has been contributed to the home building public. You will see on the following pages many designs that will delight your eyes and reveal to you the wonders of this new architecture. It is possible that you may not be intending to build a home just at the present time. But you will find here a design that you can dream about and plan to create for your abiding place in the future.

Work of Skilled Architects. Each plan has been drawn in one of the world's largest and best equipped architectural establishments by the most skilled licensed architects in the country, who have made a special study of cement house construction. The work as here shown offers designs and plans that will suit any taste and requirement, and only the best of the entire collection are shown. The aim has been in each instance to combine art with utility with a due regard for economy in materials. This is of vital importance to the home builder and to the contractor alike, for many dollars have been saved for each because the plans and specifications show how each design will work out to the very best advantage.

When the fact is considered that only a small percentage of architects have kept abreast of the times sufficiently to be equal to the demands of cement construction, and when you consider that in these plans you are getting the advantage of the latest and most approved methods of construction from the best architectural skill in the country, the merely nominal price asked for these complete plans and specifications, $10 to $15, is marvelously low.

What You Will Get. It may surprise you also to know that the plans you get for that price are exactly the same in every particular as those you would have to pay $75 to $100 for to the average architect who has gone to the expense and expended the time in perfecting himself in this latest form of building.

Best Possible to Produce. Now here is what you will get for the small price we are able to quote: You will receive the regular blue printed plans, drawn one-quarter inch scale to the foot, showing all the elevations, floor plans and all the details, in addition to full specifications covering every item of the work. These plans represent the result of many years of study of cement construction by the most skilled architects and are the best in every detail that it is possible to produce. Every plan is printed by electricity, assuring a uniform blue tone, and each print is produced in an electric circular blue printing machine on the very best grade of paper obtainable. Each line and figure is distinct and ready for the workman to use in the actual building of your house.

Never Build Without Plans. A word to you now before we describe the plans in detail. You know it is extremely hazardous

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and unwise to attempt the building of a frame house without plans. A frame house thus built invariably lacks that style desirable in a home. It is unsalable when the owner may wish to dispose of it. In the haphazard construction characteristic of building without plans there is a waste of materials and any amount of worry over mistakes in measurements, loss of time of the workmen, and countless other troubles for the owner and the contractor. If these things are characteristic of attempting to build a frame house without plans, how much more necessary is it to never set about building a cement house without good and accurately drawn plans? Guessing sometimes accidentally succeeds in the building of a frame house; in a cement house, never. Besides, bear in mind that a cement house built in accordance with a design and plans studied out by the best architectural skill of the country assures you a home that will be architecturally correct and possess the style that you will not be ashamed of. The probability is, too, that somebody will come along and want to buy it before it is completed, but, of course, whether you yield to the temptation to sell remains entirely with you.

Foundation and Cellar Plans. Now we will take up a typical set of plans and specifications and explain to you of what they consist, so that you can see how complete they are in every particular. The foundation and cellar plans show the shape and size of the walls, the piers, the footings, posts, etc., and the materials of which they are to be constructed. Every window, and door, the chimneys, ash pits, partition and every part of the construction in that part of the building is shown for the actual guidance of the builder.

Floor Plans. The floor plans show the shape and size of every room, the halls and closets, drawn like the cellar plans to the quarter inch scale, so that the builder can readily read the actual sizes by the application of his rule to the plan. The position of the plumbing fixtures is shown and all the measurements necessary are given.

Elevations. A front, right, left and rear elevation is furnished with all the plans. Each one shows the shape and size of every door, the windows, porches, cornices, towers, bays and every detail of the exterior. Also full wall sections are given, showing the height of ceilings, height of plates, height of roof, etc.

Roof Plan. Where the roof is at all intricate a roof plan is furnished. It shows all valleys, gutters, hips, ridges, etc., all on the same scale of one-quarter inch to a foot.

Details. For all the interior work details are furnished. These include the details for door and window casings, stools, picture moldings, doors, newel posts, balusters, rails, etc. Some of the details are shown in full size, while some of the larger work is drawn to the scale of one and a half inches to a foot. The blue prints are bound artistically in cloth and heavy waterproof paper.

Specifications. As any builder knows, the specifications are of little less importance than the plans themselves. The specifications we send are typewritten on bond linen paper and are bound in the same artistic manner as the plans. There are from sixteen to twenty pages of them and they give explicit instructions about every detail of the construction in the clearest and simplest language, avoiding any possibility of quibbling or misunderstanding.

Mistakes Cost Money. Mistakes which cost money can be avoided if our plans and specifications are made the basis of the contract between the owner and the contractor. They will also prevent disputes which so often prove annoying in building and seldom are settled satisfactorily to both parties. It is always wise to have a

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contract drawn up both for the protection of the contractor and the owner. Any other method is slipshod.

Many Advantages Shown. Numerous advantages may be claimed for the complete plans and specifications for a cement house. A plan drawn by an expert architect assures accuracy and style. When carelessly drawn "home made" plans are used or where no plan at all is used, numerous difficulties arise, principally from the waste of materials through errors in measurements, and the house lacks style. Workmen will not have to wait for instructions when a properly drawn set of plans is left on the job. They are therefore time savers and money savers. They also give instructions for the working of all materials to the best advantage.

Record Kept For You. This is important to you. Without any cost to you or without any trouble to you a record of the house design and the date it was furnished to you is kept by us, so that in time of loss it will only be necessary for you to drop us a line and we will furnish you the only reliable method of getting a speedy and satisfactory adjustment.

How We Can Do It. The question often is asked, "How can you furnish a complete set of working blue prints and specifications at a price so low?" It is not to be wondered at that this question should be asked, for the work you receive is exactly the same as that you would pay an architect in your town $75 to $100 for. We could not furnish these plans at the price we quote but for our great organization equipment that enables us to produce them at the minimum cost which is divided among many. And dividing the cost among a very large number we are enabled to furnish them at a very small margin of profit, for we sell thousands of sets of plans which save many times their cost to the owner and contractor alike.

Bills of Material. We think you will readily understand why we cannot furnish a bill of materials or state the cost of the houses shown. The various makes of blocks and the various brands of cement do not have a fixed price that will apply to all sections of the country. Even the cost of gravel varies, depending upon the distance it has to be hauled. Besides, tastes differ in various parts of the country and while one builder might want a more elaborate finish or more expensive woods on the interior, another would not want it. Our advice to you is this: If you see in the following pages the design of a house that you want to build, consult your responsible contractor and responsible dealer, who will be able from the plans to figure out for you the cost, for he has in his office the freight schedules and he knows the cost of labor in your locality.

We Are Frank With You. Every statement we make to you we are prepared to substantiate in every respect. We have told you that economy has ruled in the design of all these houses. Look them over. If there is any one that pleases you we set before you this claim—it can be built as cheaply as if any other architect designed it, and we believe cheaper, for economy has been our guide in every instance.

Economy Our Study. You know that men who are constantly in the business of designing are in a position to study economy in the selection of materials and sizes. That is our business. We give you a plan that embodies all our observations and research in the matter of economy in space and the use of materials. No architect can do any more at ten times the price we charge you for the plans.

Reversing Plans. We have often received requests to furnish the reverse of a given set of plans, it being the desire of the home builder to use a certain plan, but

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he wants to face his house differently than the plan provides for. It is impossible for us to furnish the reverse of a set of plans except at about eight times the cost of the original. It would appear that in case it is desired to reverse a plan a contractor or builder can readily adapt himself to these plans. We can, however, make a reversed blue print, but the figures would be reversed and cause confusion in the reading of them.

Our Advice to You. In every instance where it is desired to reverse the plan we would advise the ordering of two sets, one regular and the other reversed. Especially will this be advisable if there is any doubt about the contractor being able to do the work. In such cases we furnish the two sets of plans and one set of specifications for only fifty per cent added to the regular price, making a $10 set $15.

Our Blue Print Plan Guarantee. If you do not find these plans as good as any you ever saw, or as good as those any architect in the world can produce, or if you find them faulty or in error in any particular, or if you do not find them complete and accurate as to figures and measurements, we will refund your money.

Of What Our Plans Consist:

All plans are drawn one-quarter inch scale to the foot.

We use the best quality Electric Blue Print paper.

We furnish for a set of plans:

Front Elevation, Right Elevation, Left Elevation, Rear Elevation, all Floor Plans, Cellar and Foundation Plans, all necessary details.

Specifications consist of 25 pages of typewritten matter, giving full directions for carrying out the work.

Both the plans and specifications are bound in cloth and heavy waterproof paper, in an artistic and substantial manner.

The plans and specifications are full, complete and accurate in every particular, and guaranteed.

Our equipment is so complete that we can mail out, the same day the order is received, a plan of any house illustrated in this book.

Why Our Plans Should be Used:

They can be made the basis of contract between owner and contractor.

They will prevent mistakes, which cost money.

They will prevent disputes, which are unpleasant and never settled satisfactorily to both parties.

Time and money are saved by having on the job plans and specifications for the workmen to consult.

With them it will not be necessary to waste time waiting for the owner or contractor to direct the work.

It costs but little more to have a modern, convenient and pretty home, than an old style box house.

Any slight, unimportant changes which may be desired can be noted on the plan and entered in the book of specifications, thereby having a record.

They will save money for the material dealer, because the sizes of all openings are plainly specified, and there is no chance for error or dispute.

They will save many times their cost during the erection of any house.

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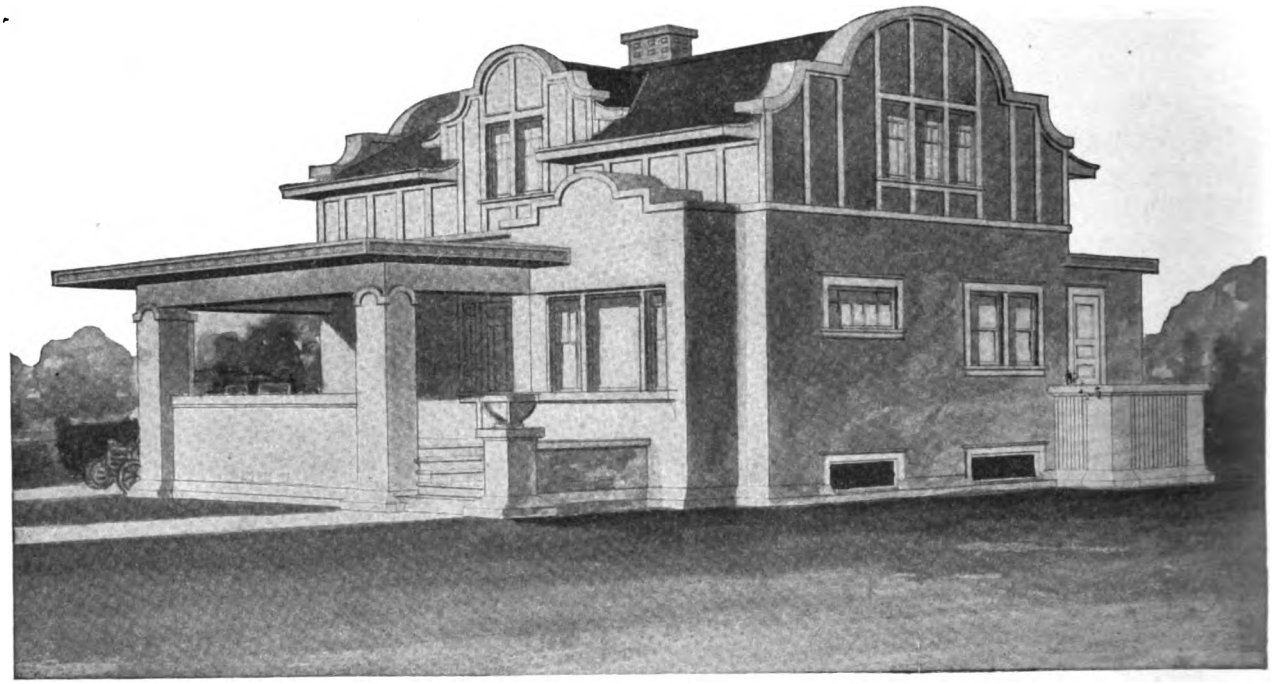
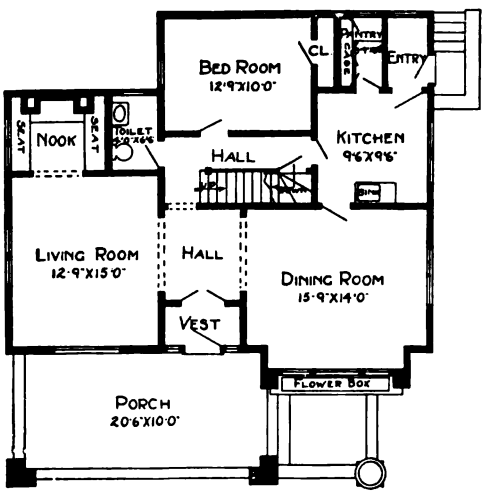
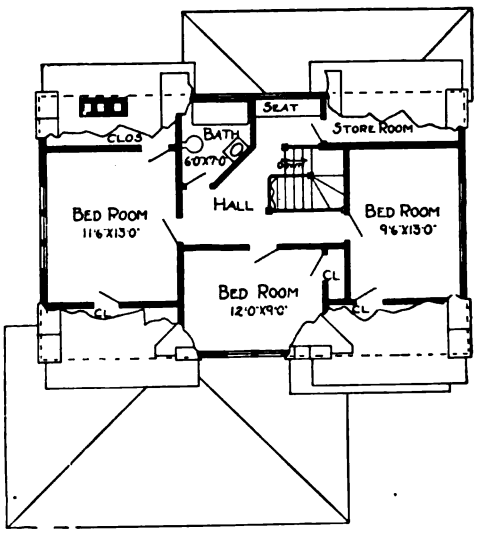


Design No. 8206

Size: Width, 37 feet; Length, 31 feet 6 inches



First Floor Plan



Second Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY FIFTEEN DOLLARS

We mail Plans and Specifications the same day order is received.

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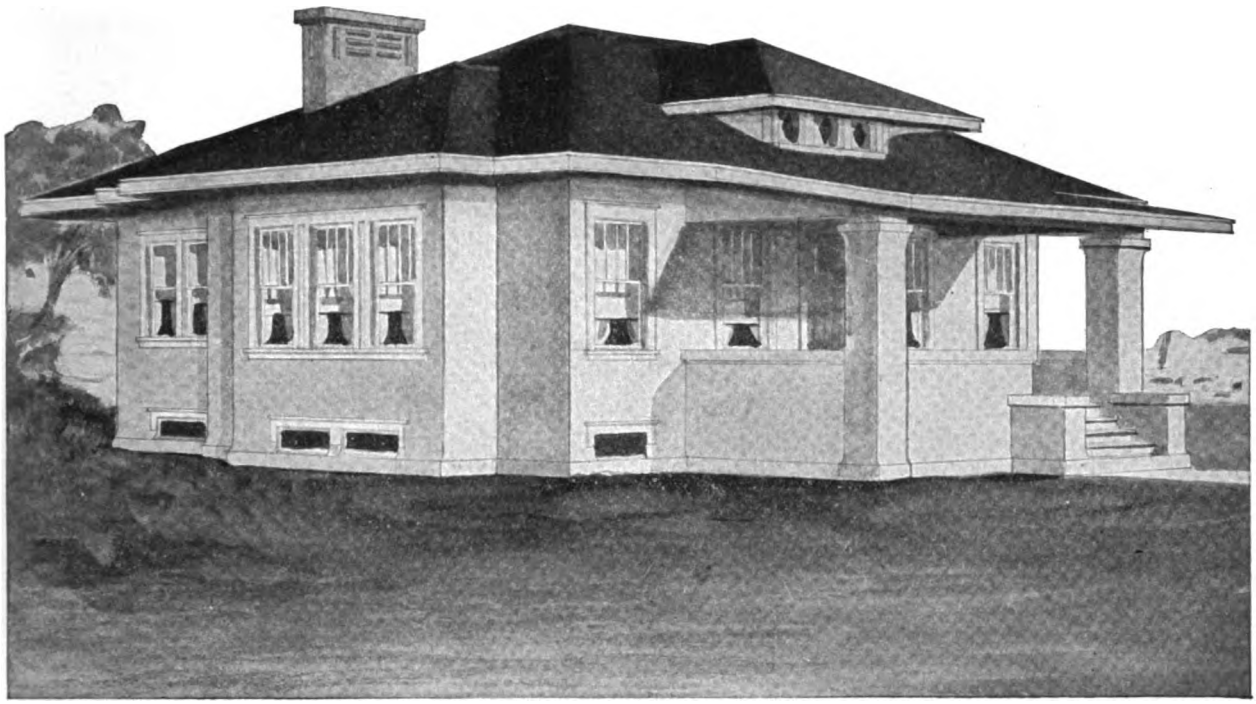
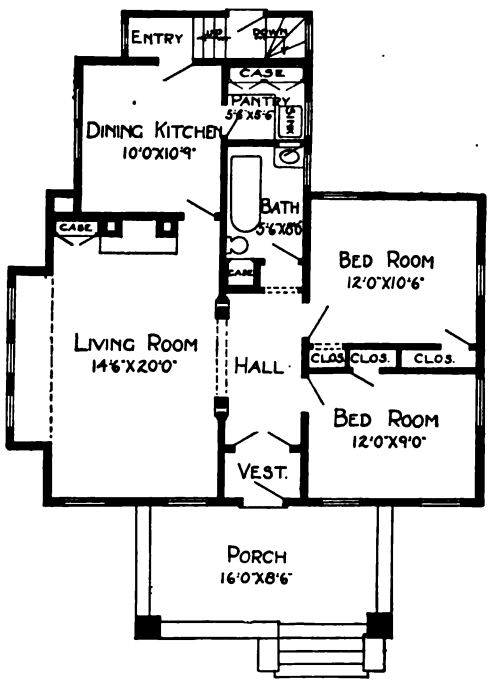


Design No. 8209

Size. Width, 34 feet 4 inches; Length, 35 feet 6 inches

Blue prints consist of basement plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

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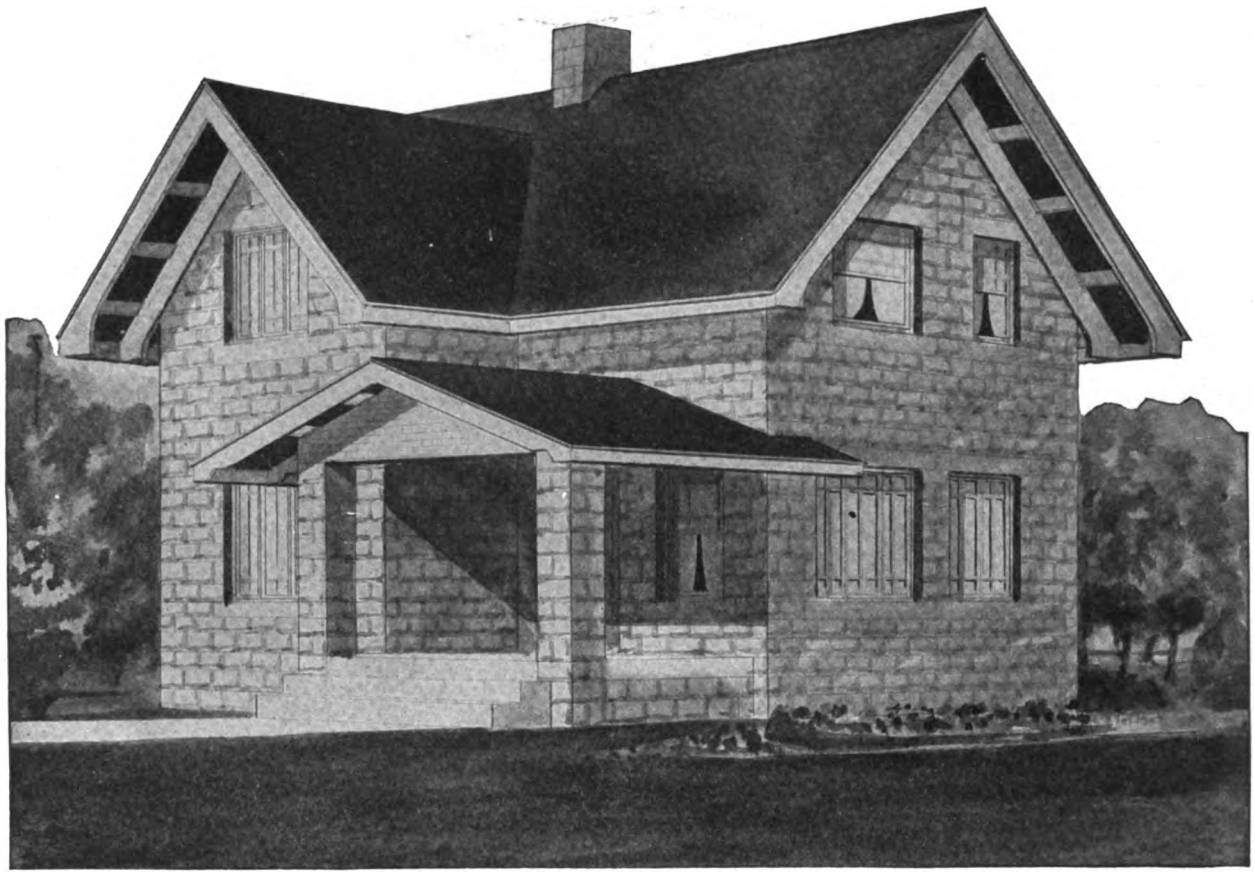
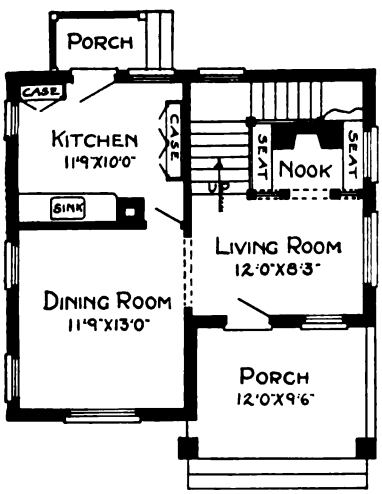


Design No. 8207

Size: Width, 26 feet; Length, 24 feet 8 inches



First Floor Plan

Blue prints consist of foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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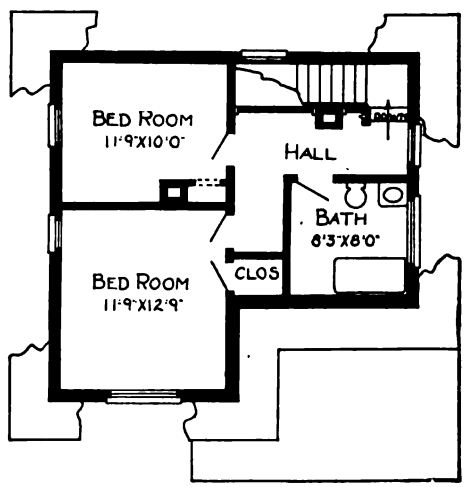
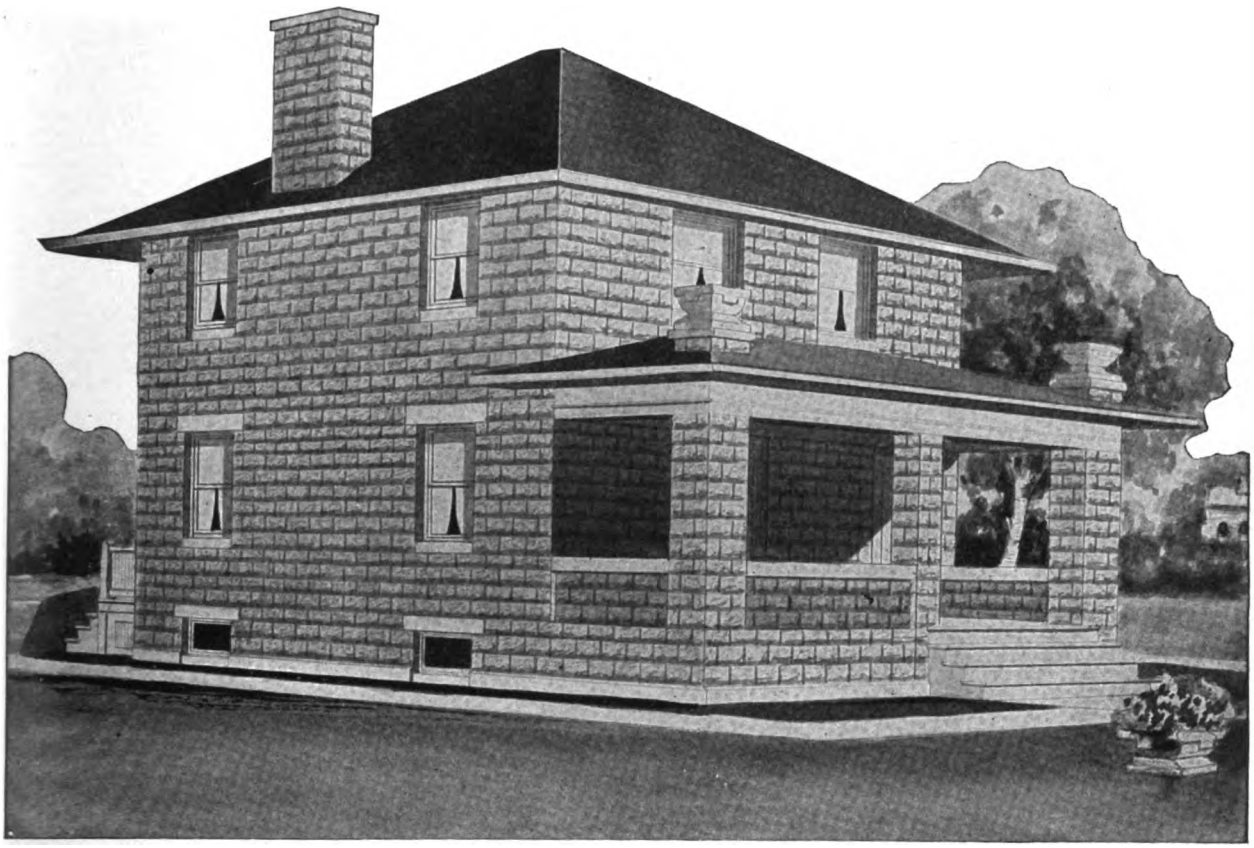


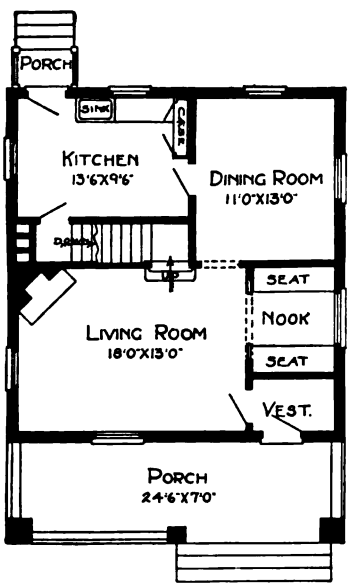
Second Floor Plan

Digitized by Google



Design No. 8203

Size: Width, 26 feet 8 inches; Length, 28 feet



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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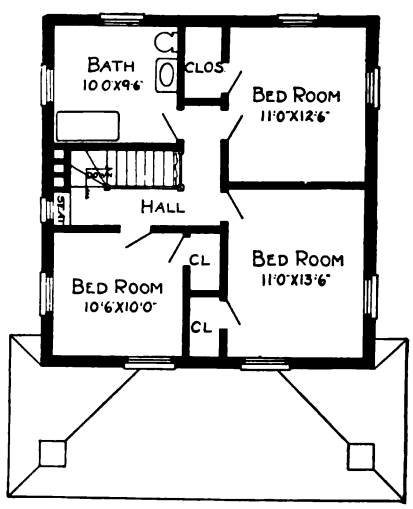

Second Floor Plan

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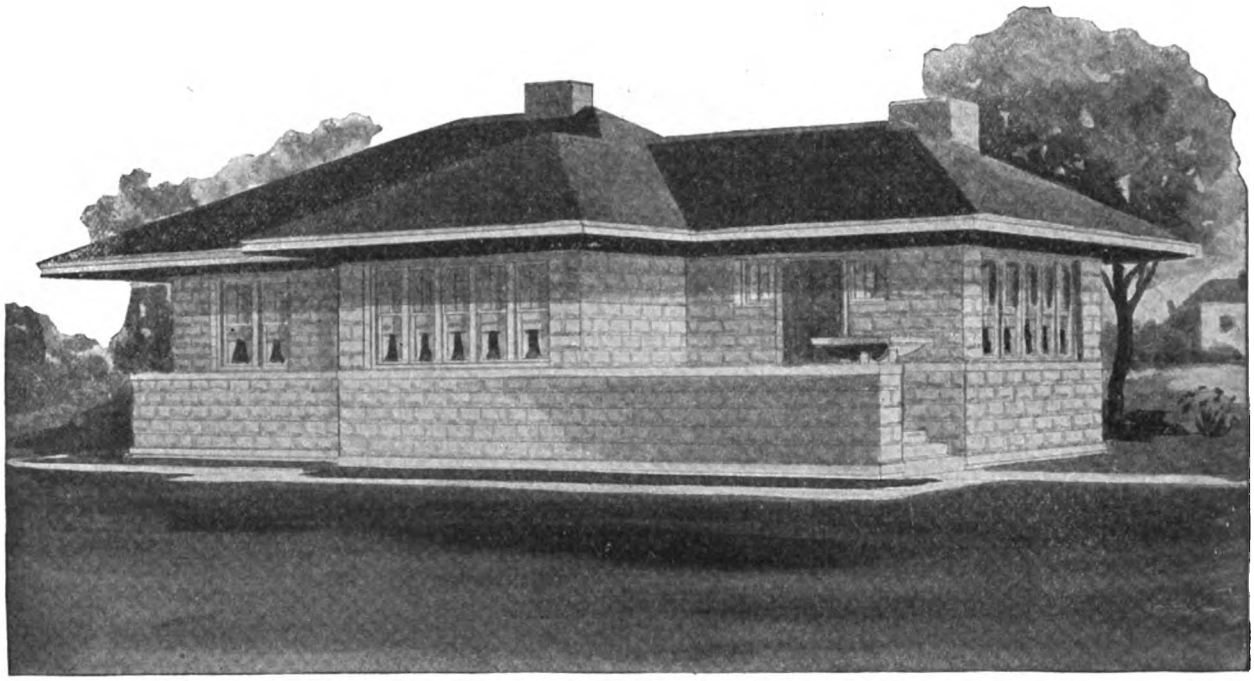
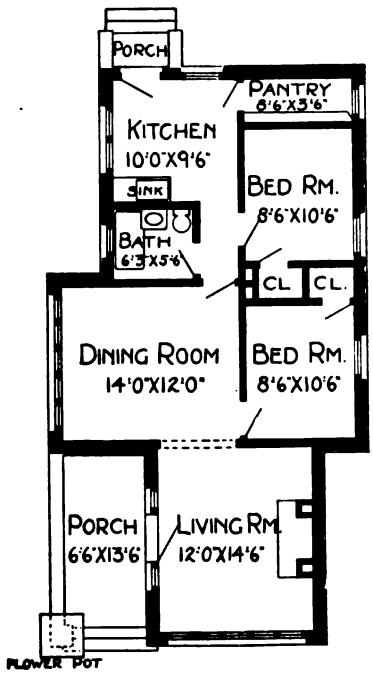


Design No. 8227

Size: Width, 25 feet 4 inches; Length, 45 feet 4 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.

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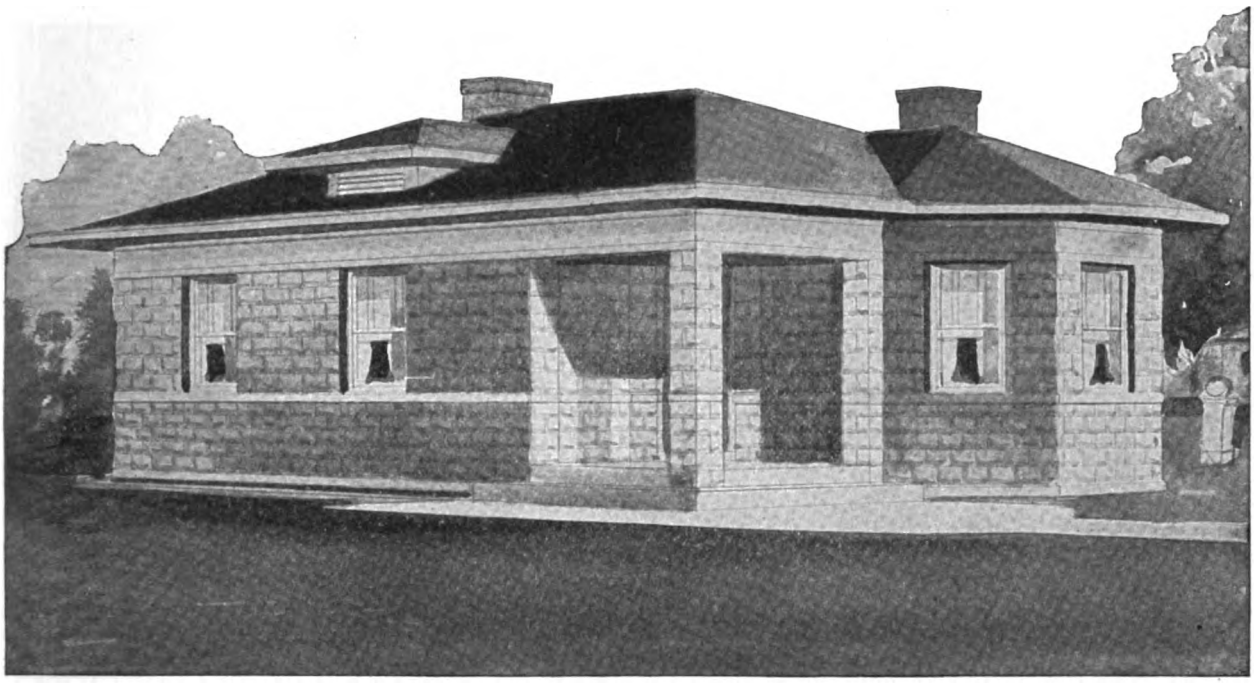
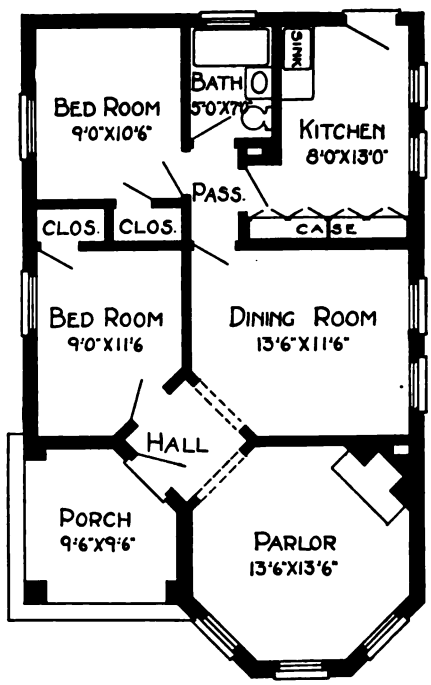


Design No. 8216

Size: Width, 24 feet 8 inches; Length, 40 feet 8 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

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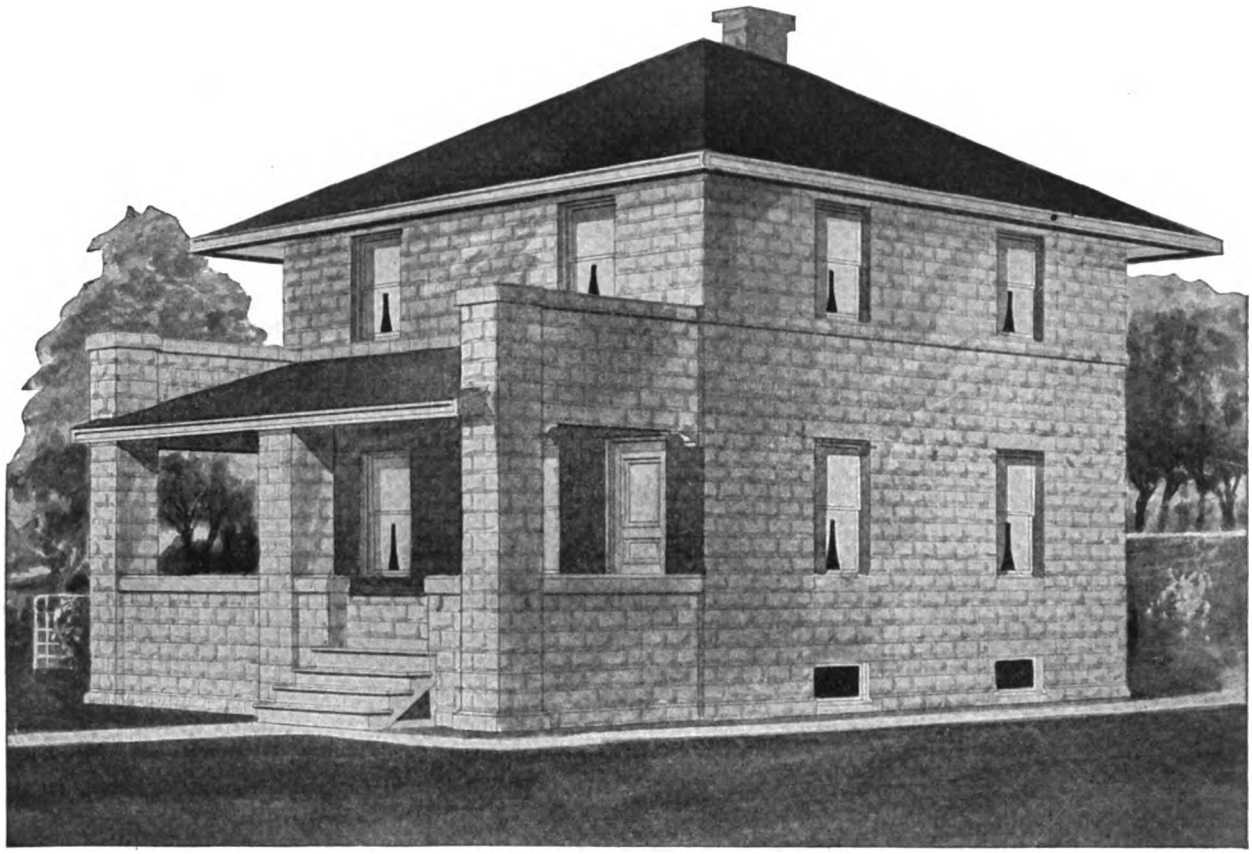
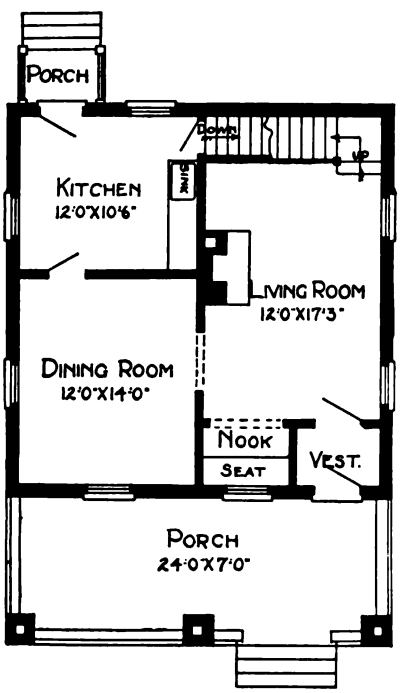


Design No. 8213

Size: Width, 26 feet; Length, 26 feet 8 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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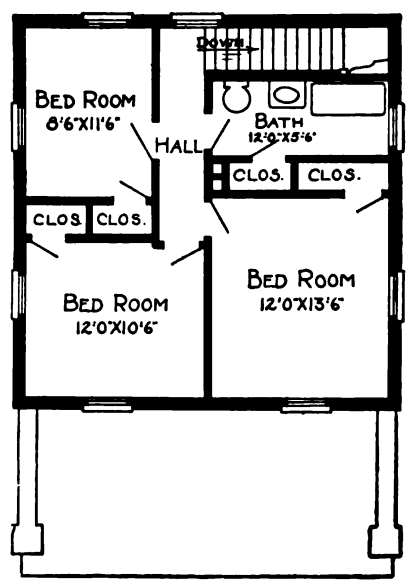

Second Floor Plan

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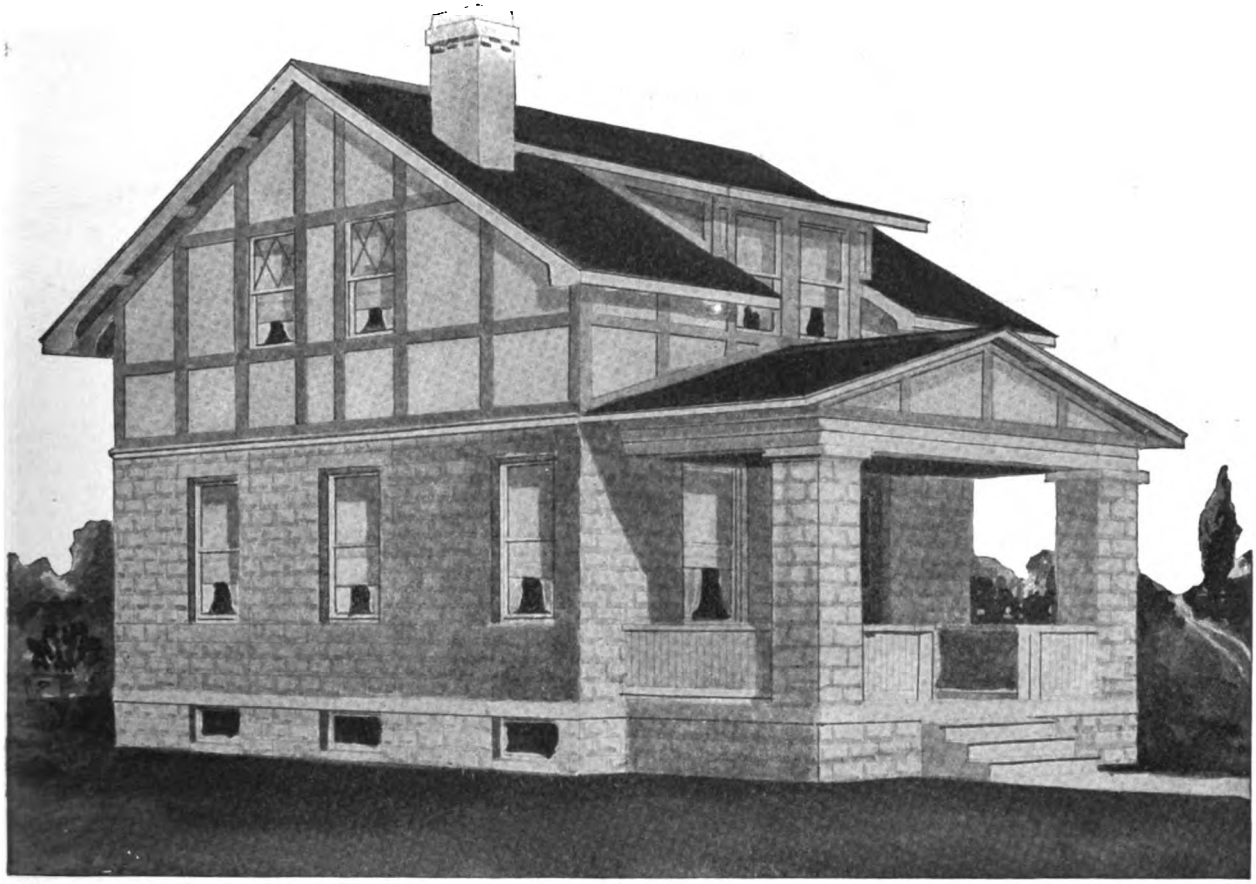
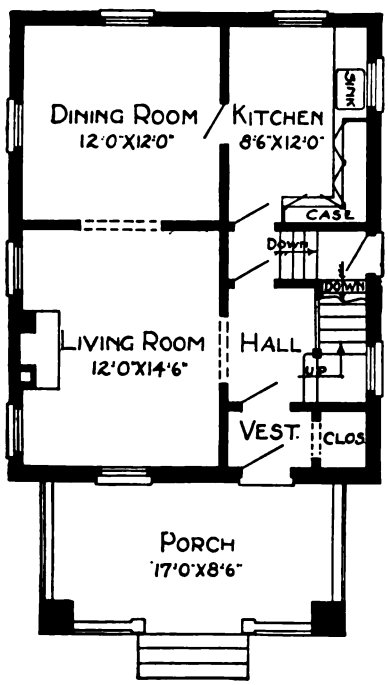


Design No. 8217

Size: Width, 22 feet 8 inches; Length, 23 feet 8 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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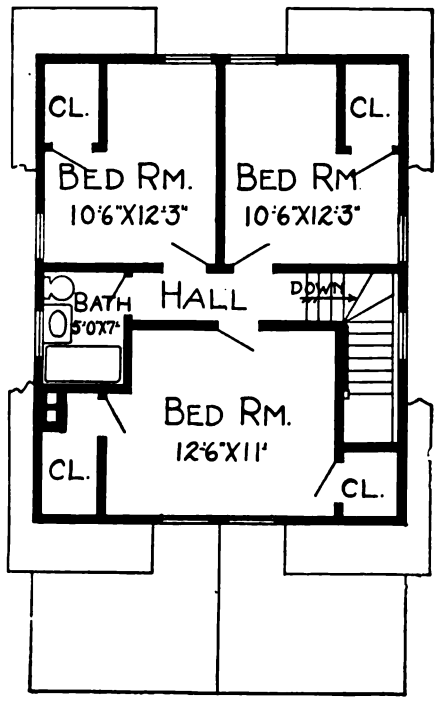

Second Floor Plan

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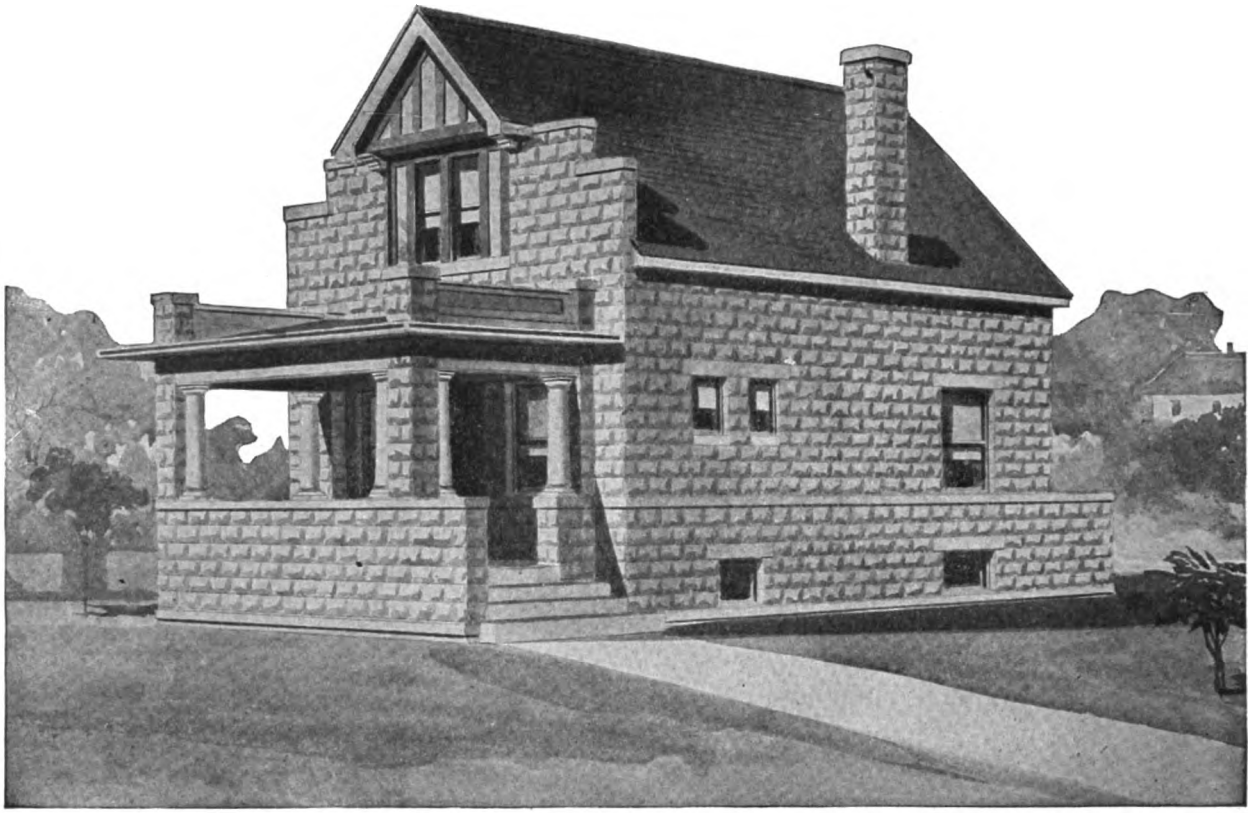
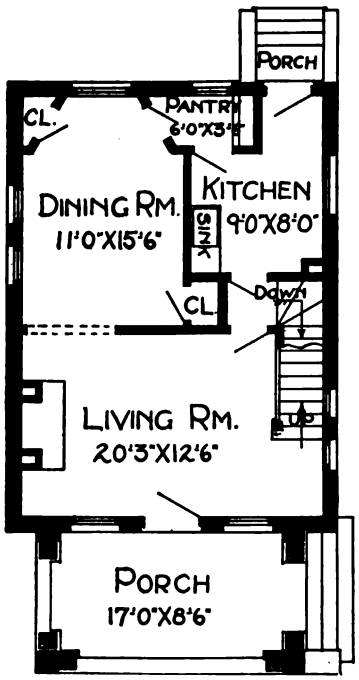


Design No. 8234

Size: Width, 22 feet 4 inches; Length, 30 feet 4 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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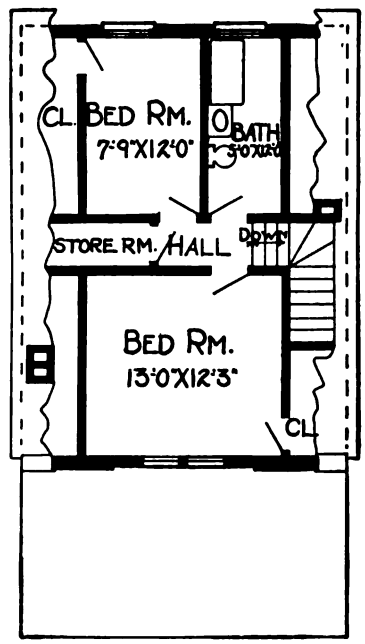

Second Floor Plan

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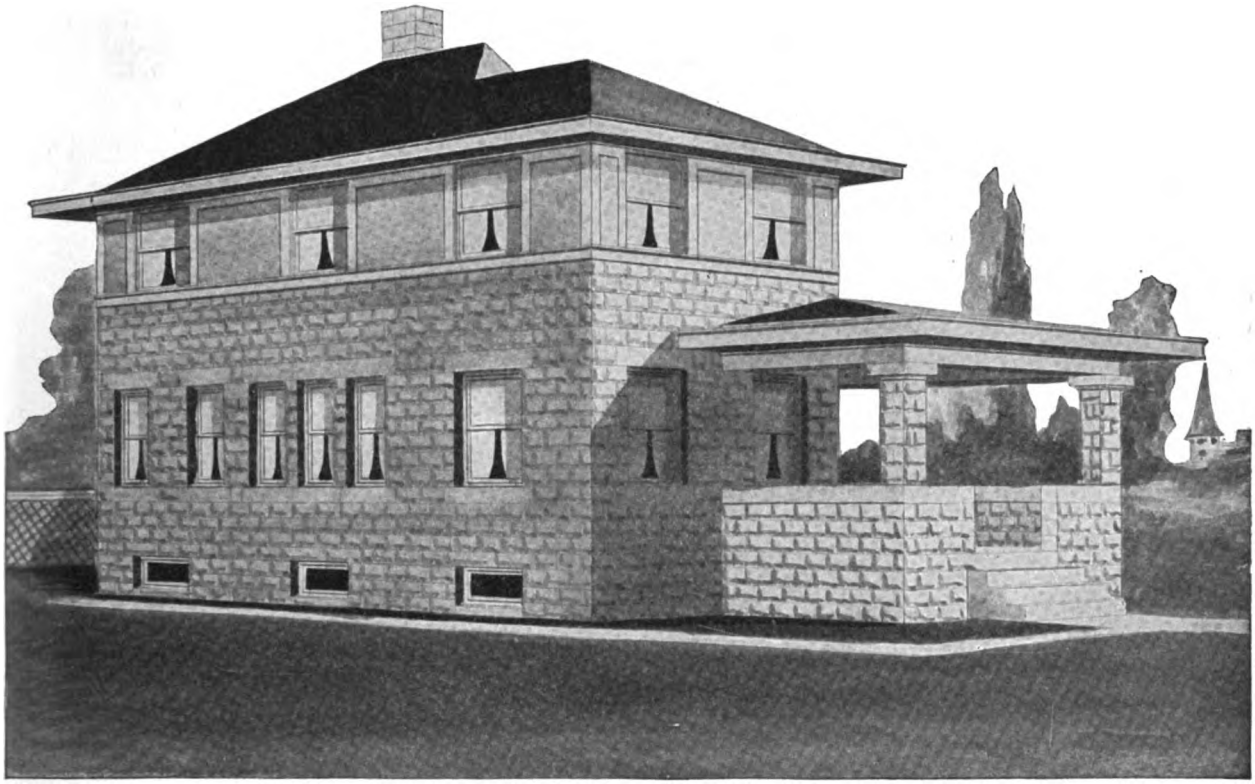
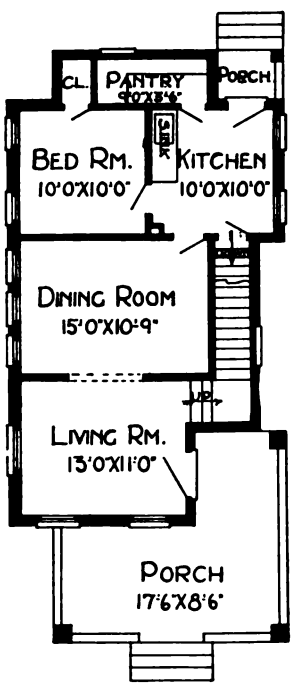


Design No. 8231

Size: Width, 22 feet; Length, 38 feet 4 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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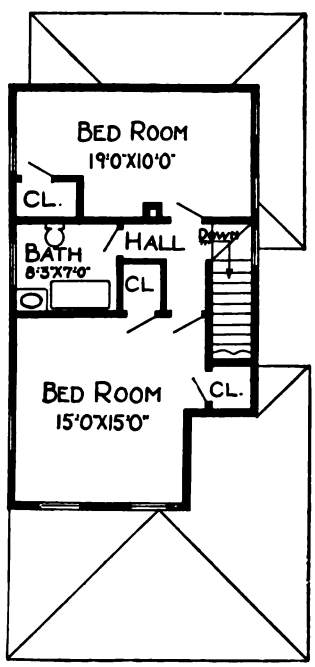
We mail Plans and Specifications the same day order is received.



Second Floor Plan

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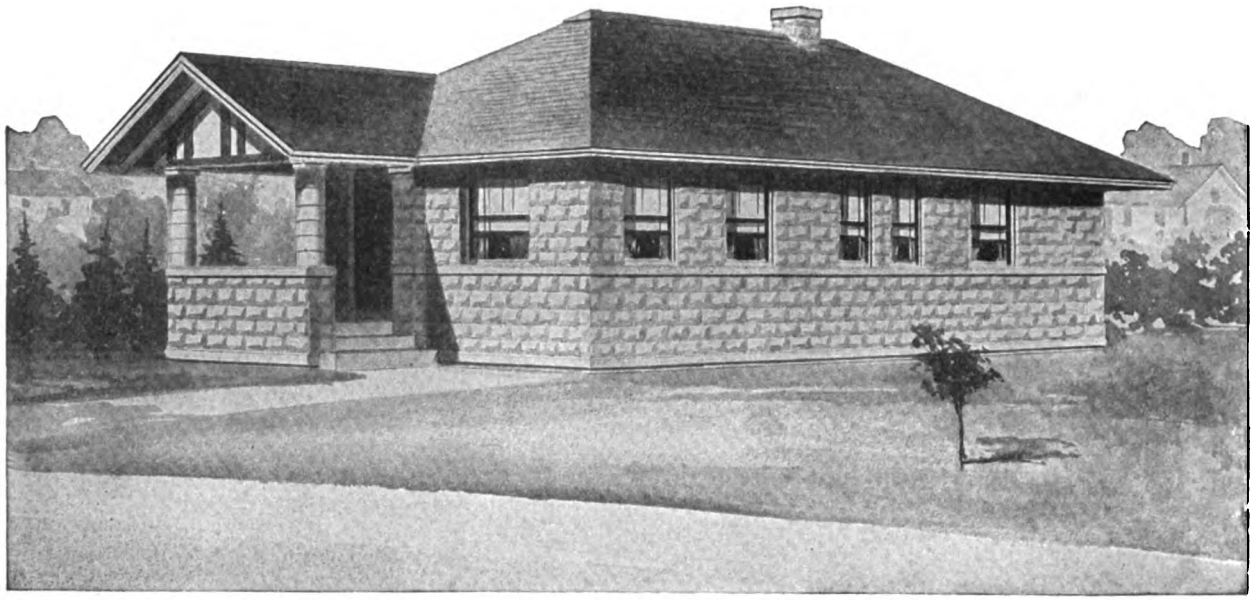


Design No. 8222

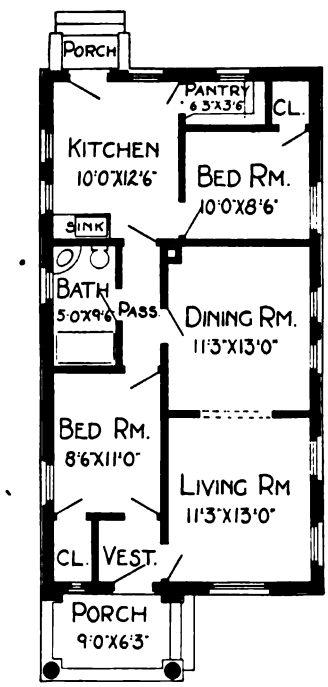
Size: Width, 22 feet 4 inches; Length, 41 feet 4 inches

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

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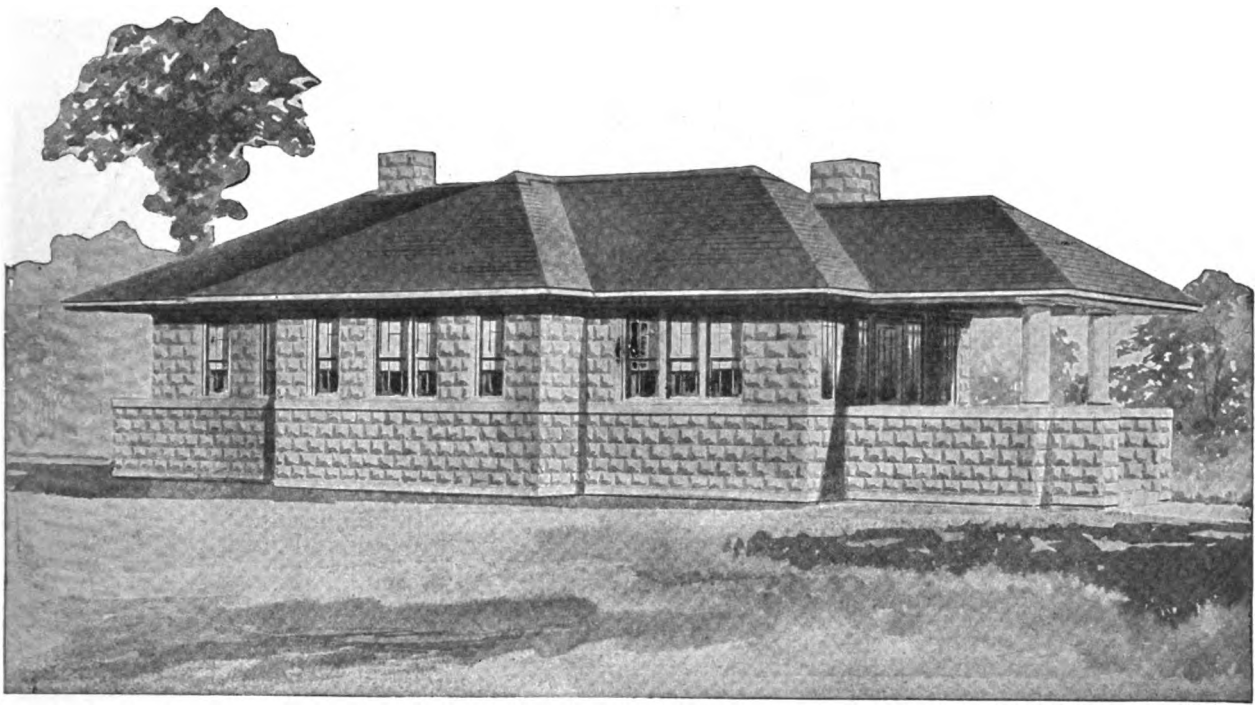
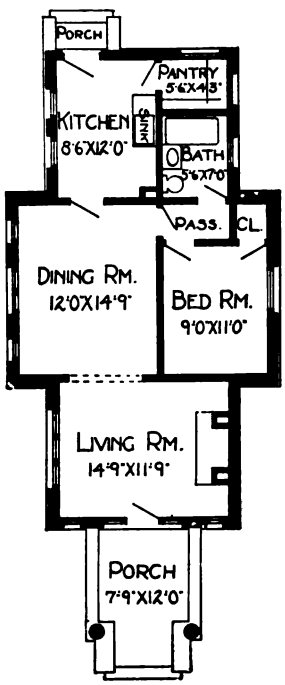


Design No. 8236

Size: Width, 23 feet 8 inches; Length, 41 feet 4 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

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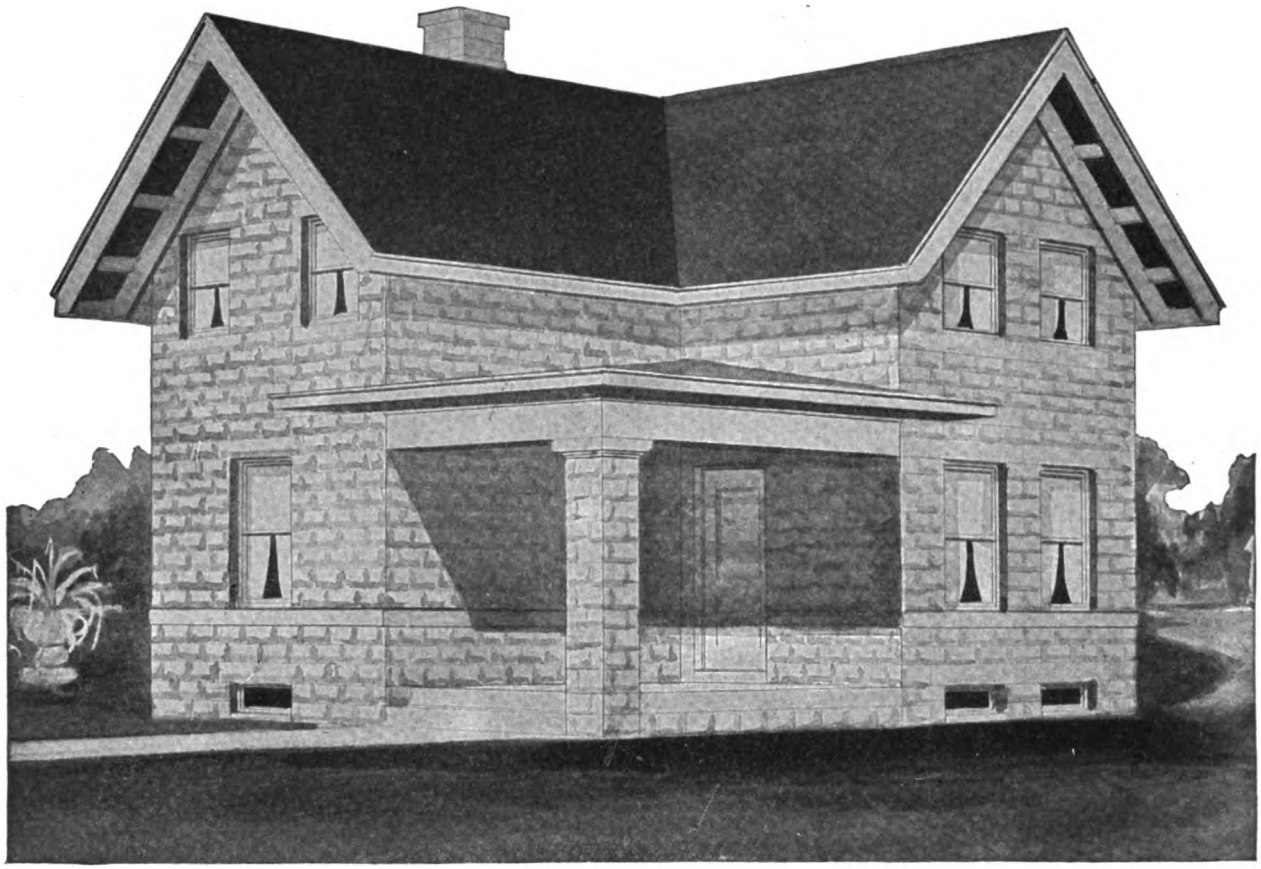
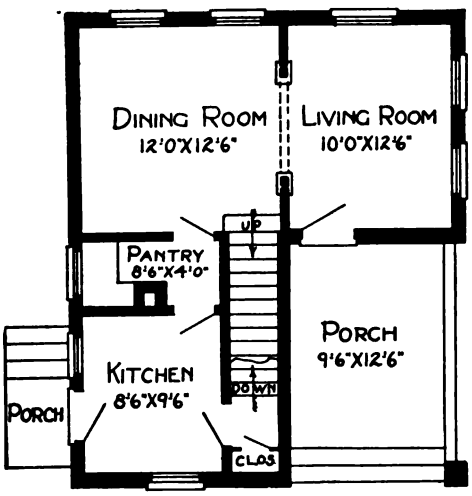
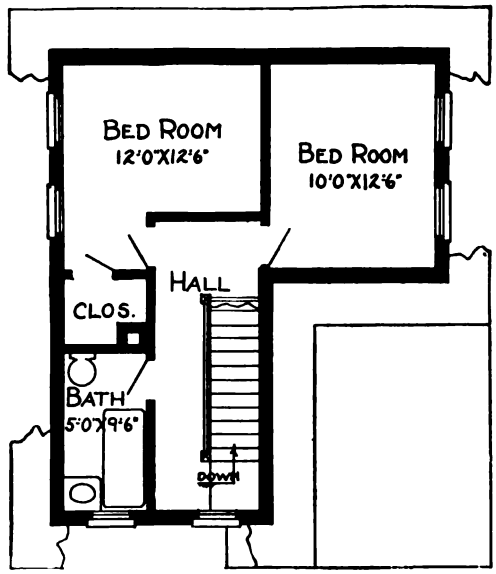


Design No. 8211

Size: Width, 24 feet; Length, 28 feet 8 inches



First Floor Plan



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear and two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

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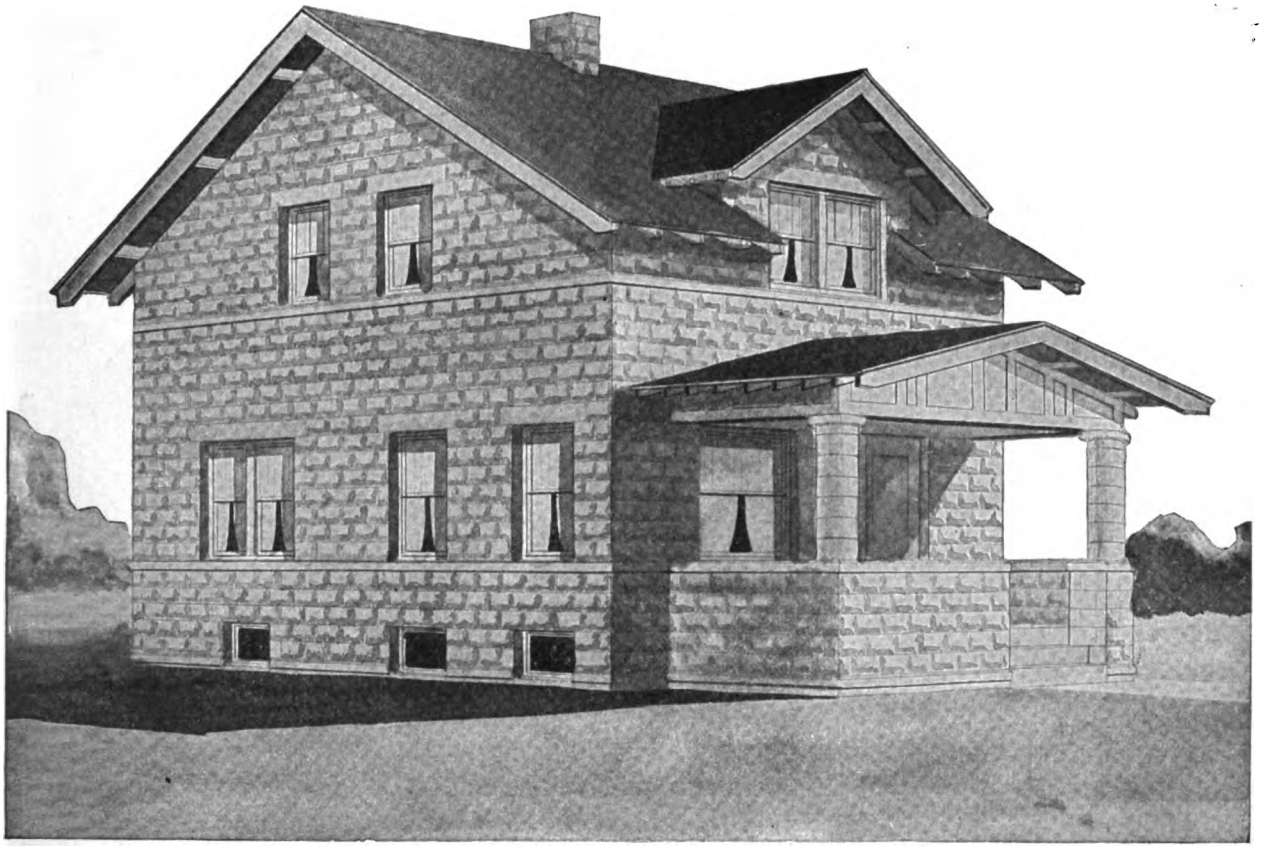
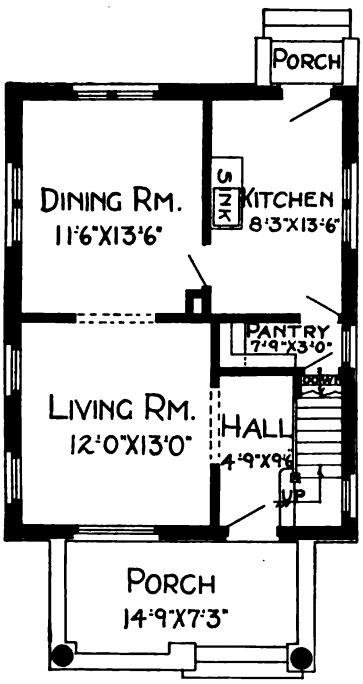


Design No. 8232

Size: Width, 22 feet 4 inches; Length, 28 feet 8 inches



First Floor Plan

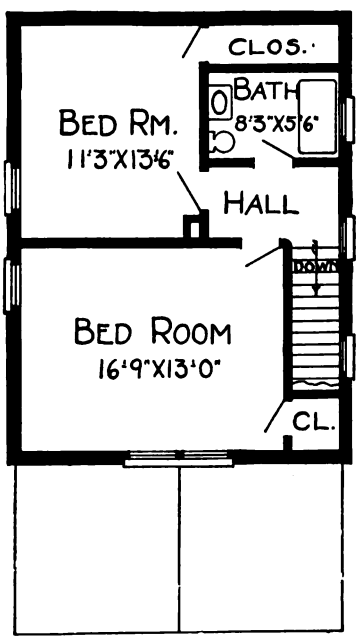
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations, wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

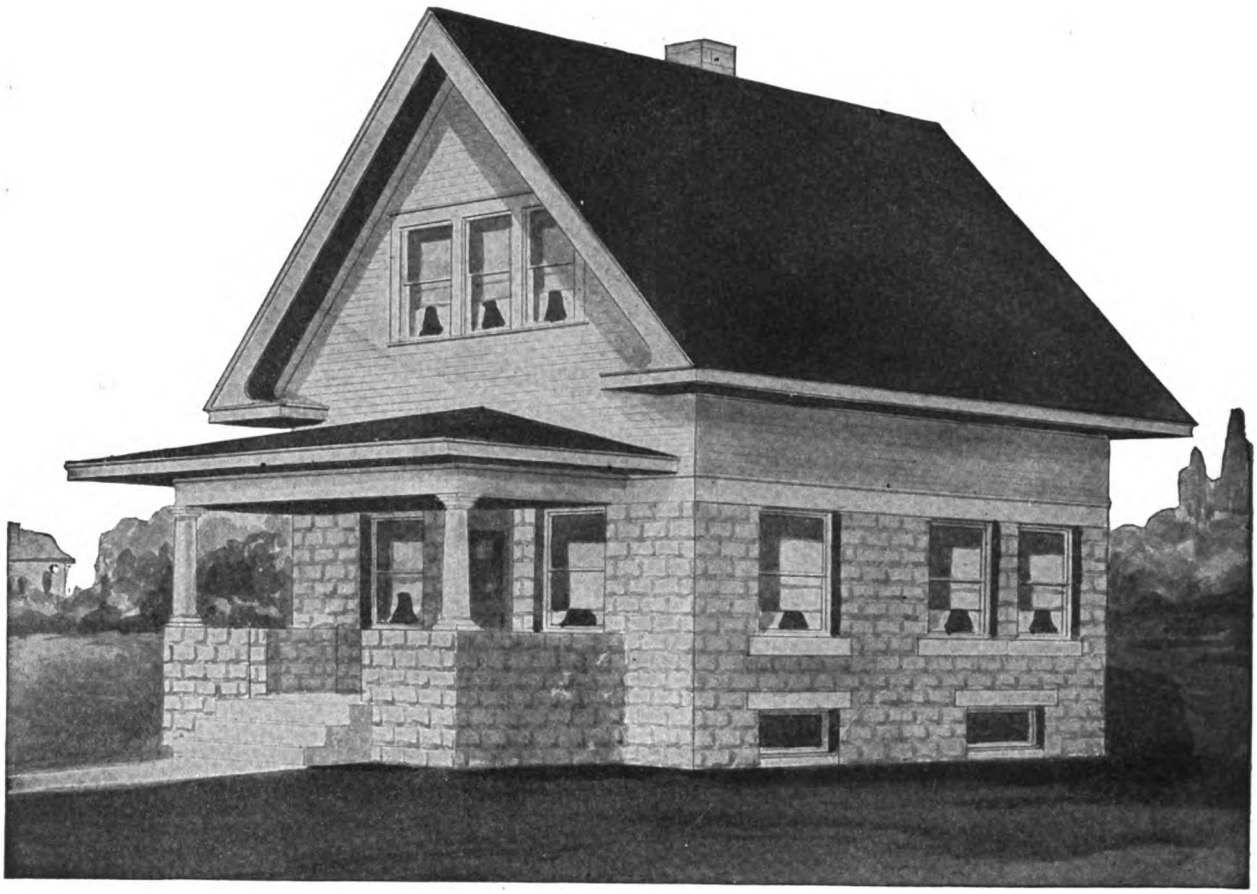
ONLY FIFTEEN DOLLARS

We mail Plans and Specifications the same day order is received.



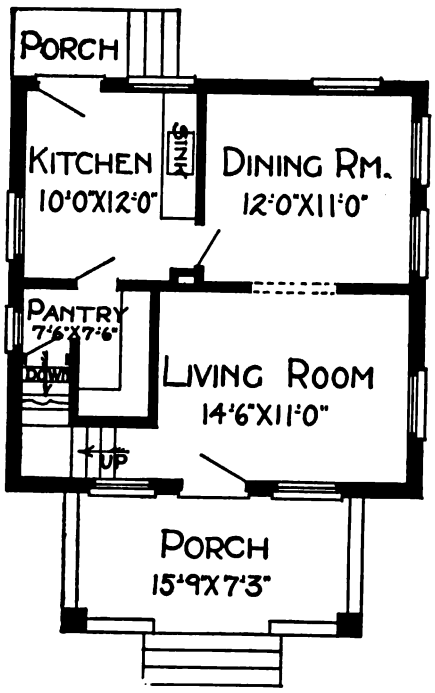
Second Floor Plan

Digitized by Google



Design No. 8228

Size: Width, 24 feet; Length, 24 feet



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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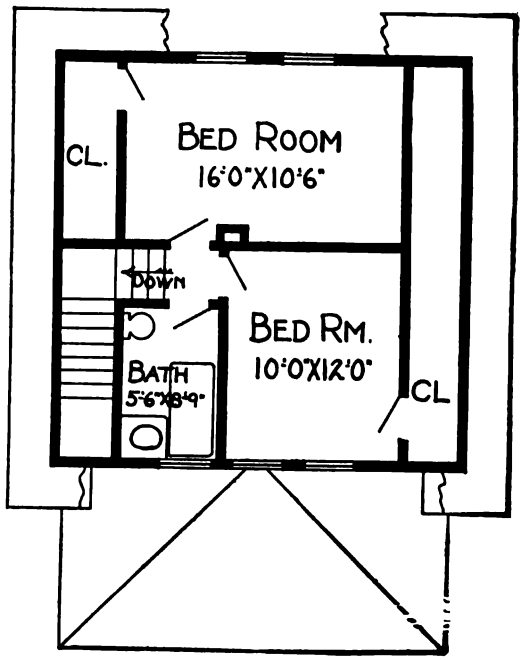
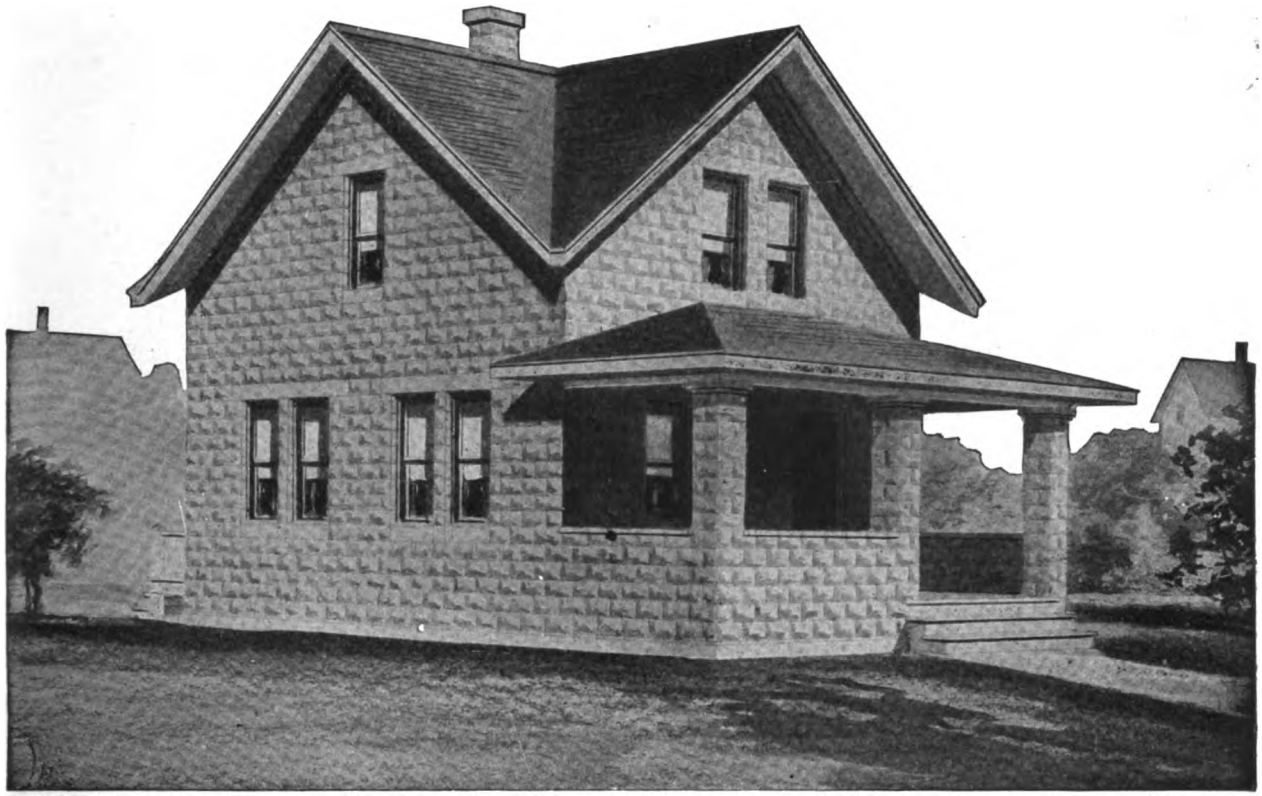


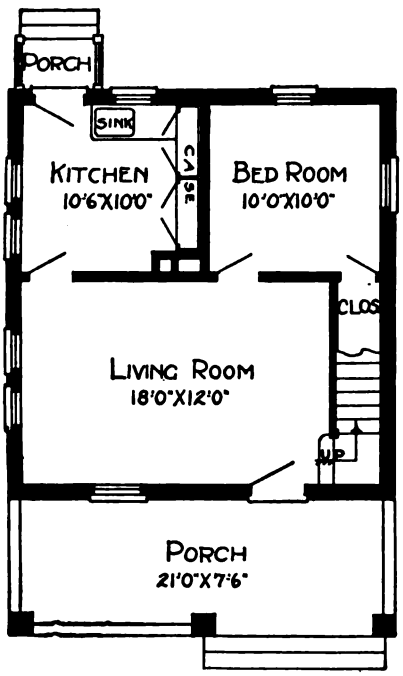
Second Floor Plan

Digitized by Google



Design No. 8204

Size: Width, 22 feet 8 inches; Length, 24 feet



First Floor Plan

Blue prints consist of foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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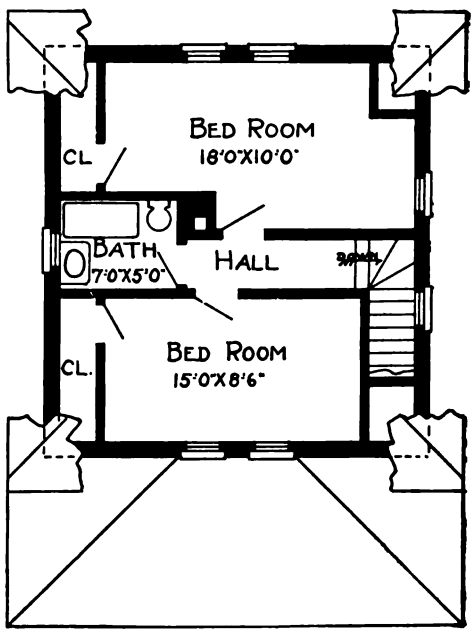
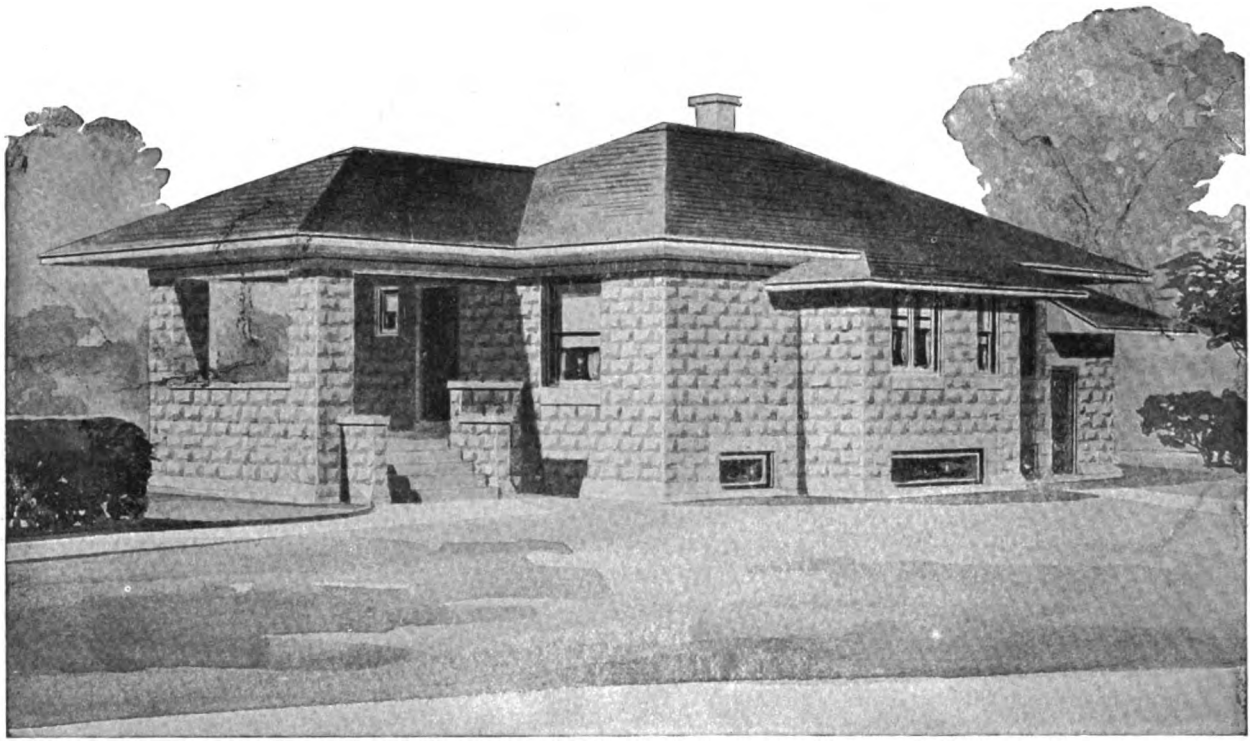


Second Floor Plan

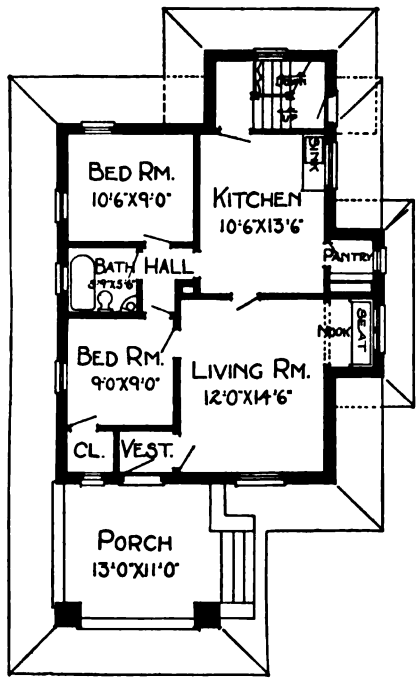
Digitized by Google



Design No. 8254

Size: Width, 27 feet 4 inches; Length, 36 feet 4 inches

Blue prints consist of basement plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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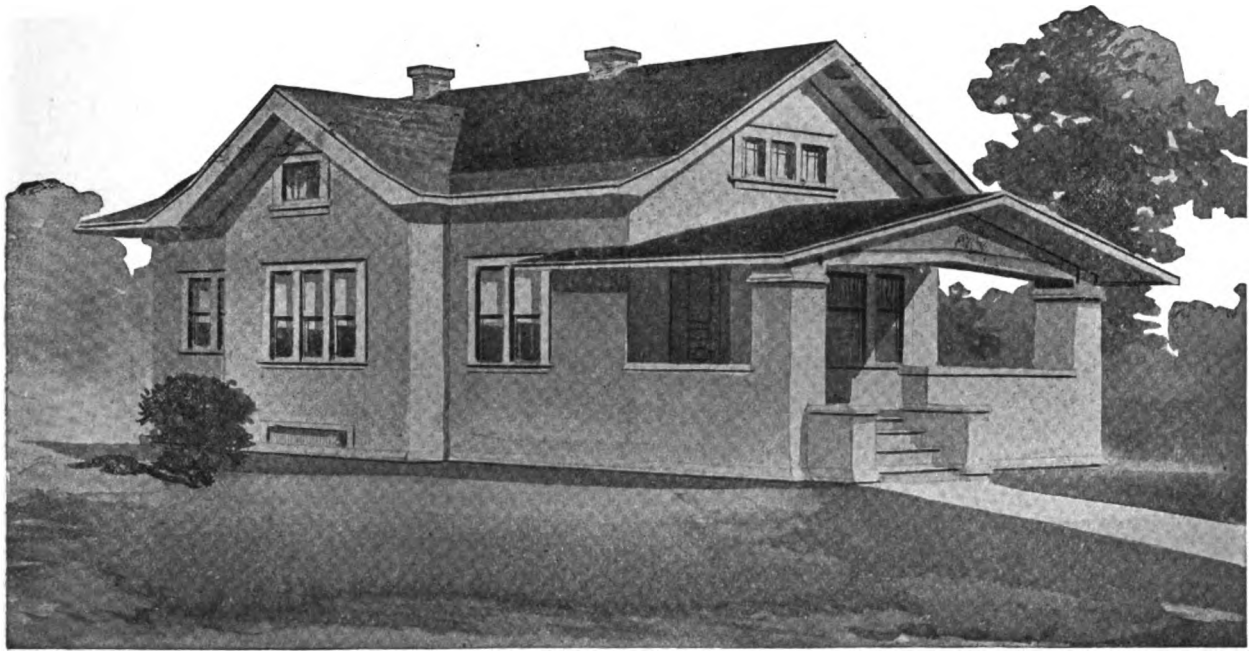
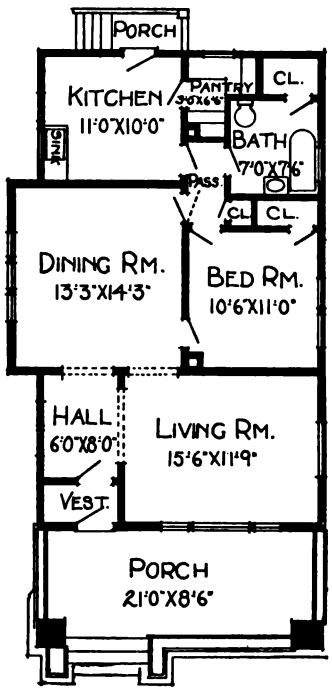
Digitized by Google



Design No. 8245

Size: Width, 25 feet 6 inches; Length, 38 feet 4 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

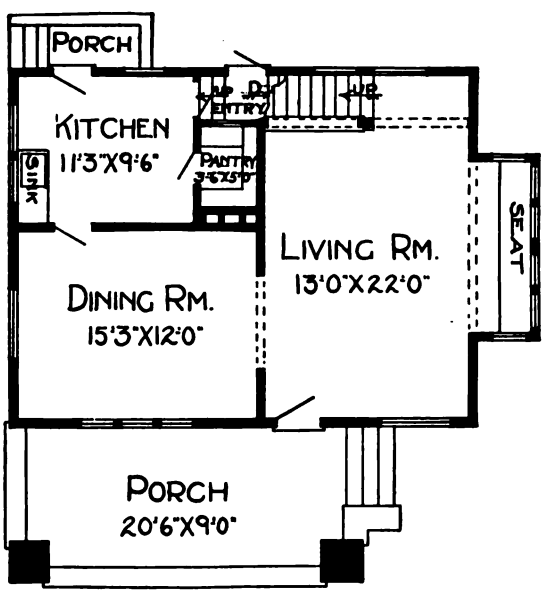
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google

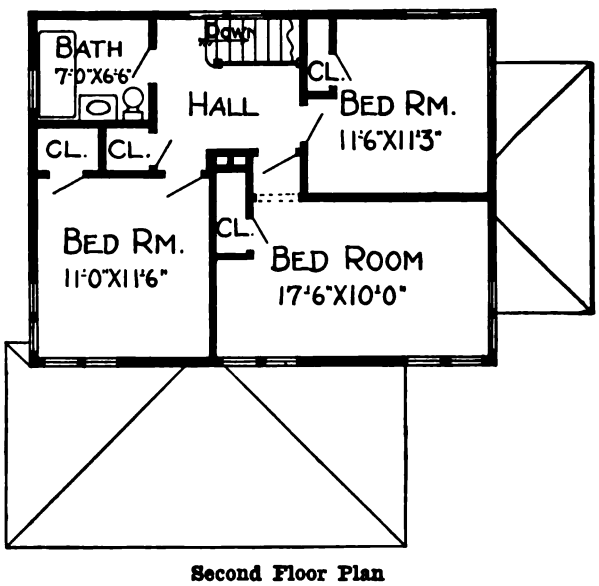
Design No. 8238

Size: Width, 34 feet; Length, 23 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; drst and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY FIFTEEN DOLLARS

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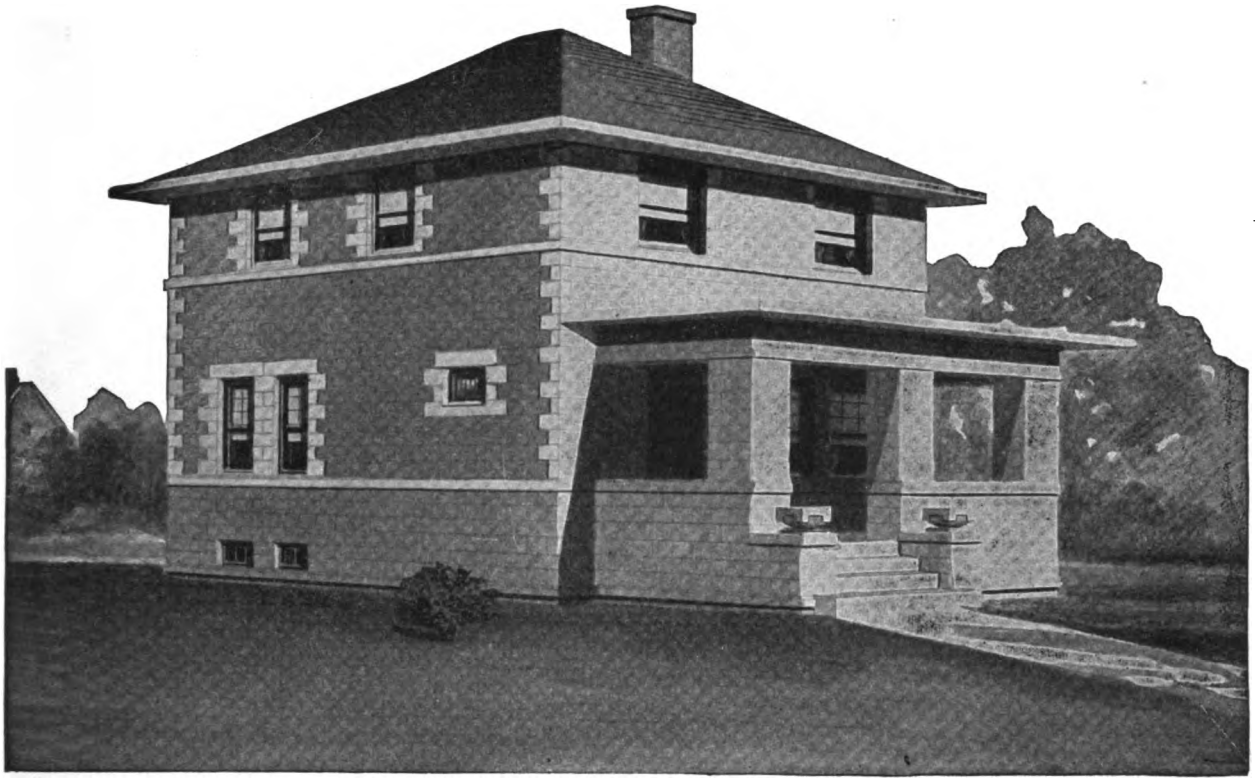
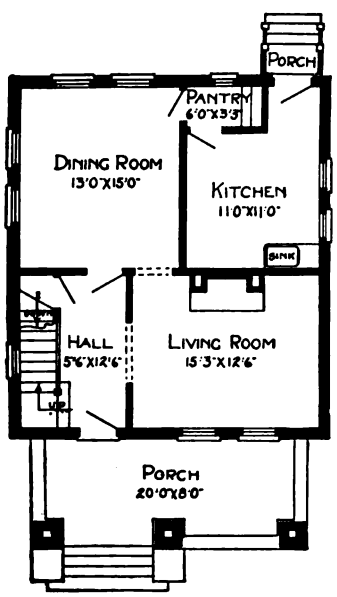
Digitized by Google



Design No. 8198

Size: Width, 26 feet; Length, 29 feet 4 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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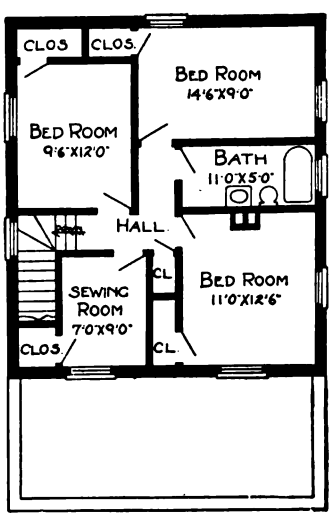
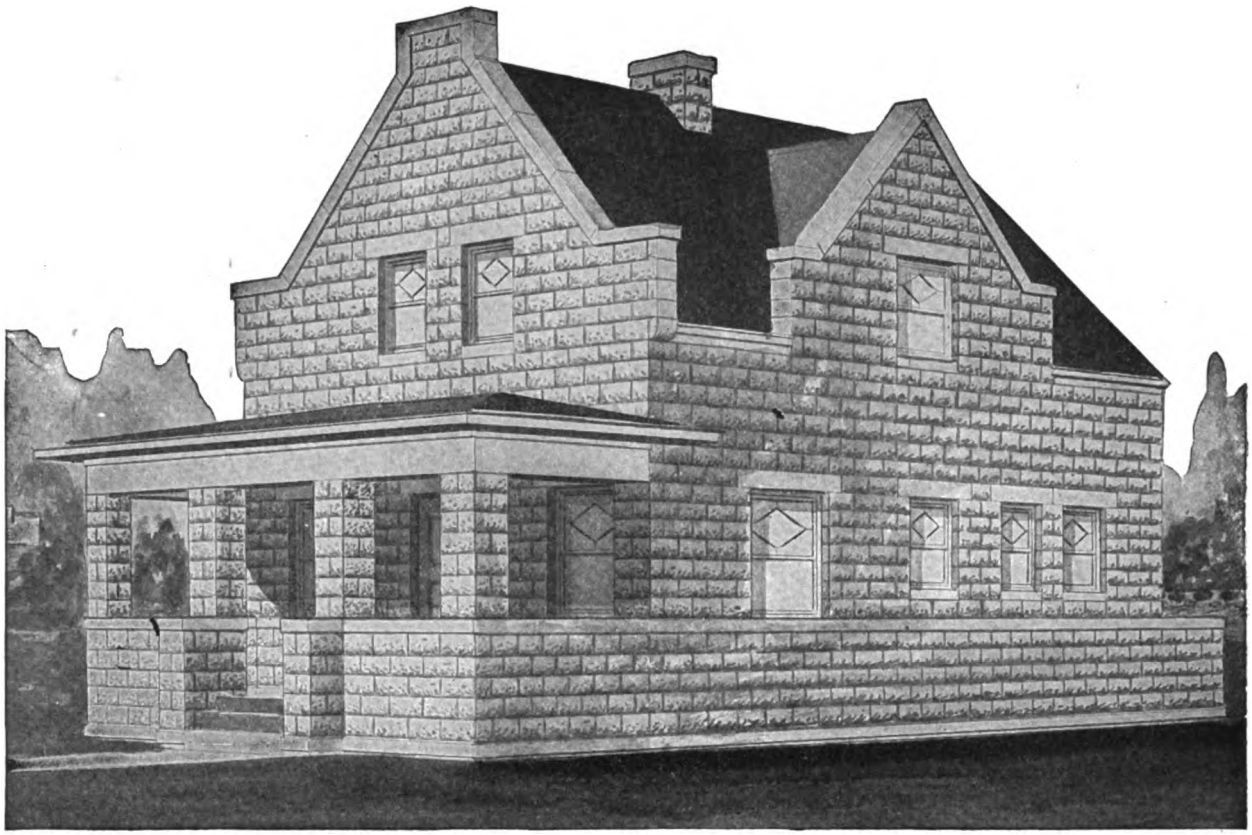


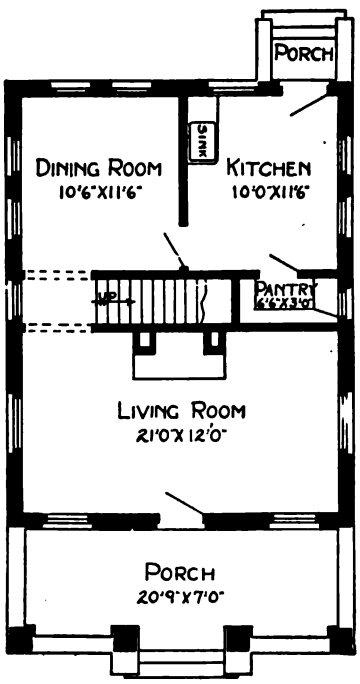
Second Floor Plan

Digitized by Google



Design No. 8208

Size: Width, 22 feet 8 inches; Length, 29 feet 8 inches



First Floor Plan

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PRICE

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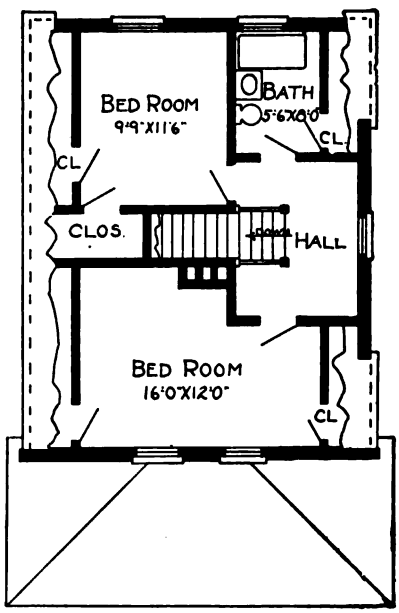
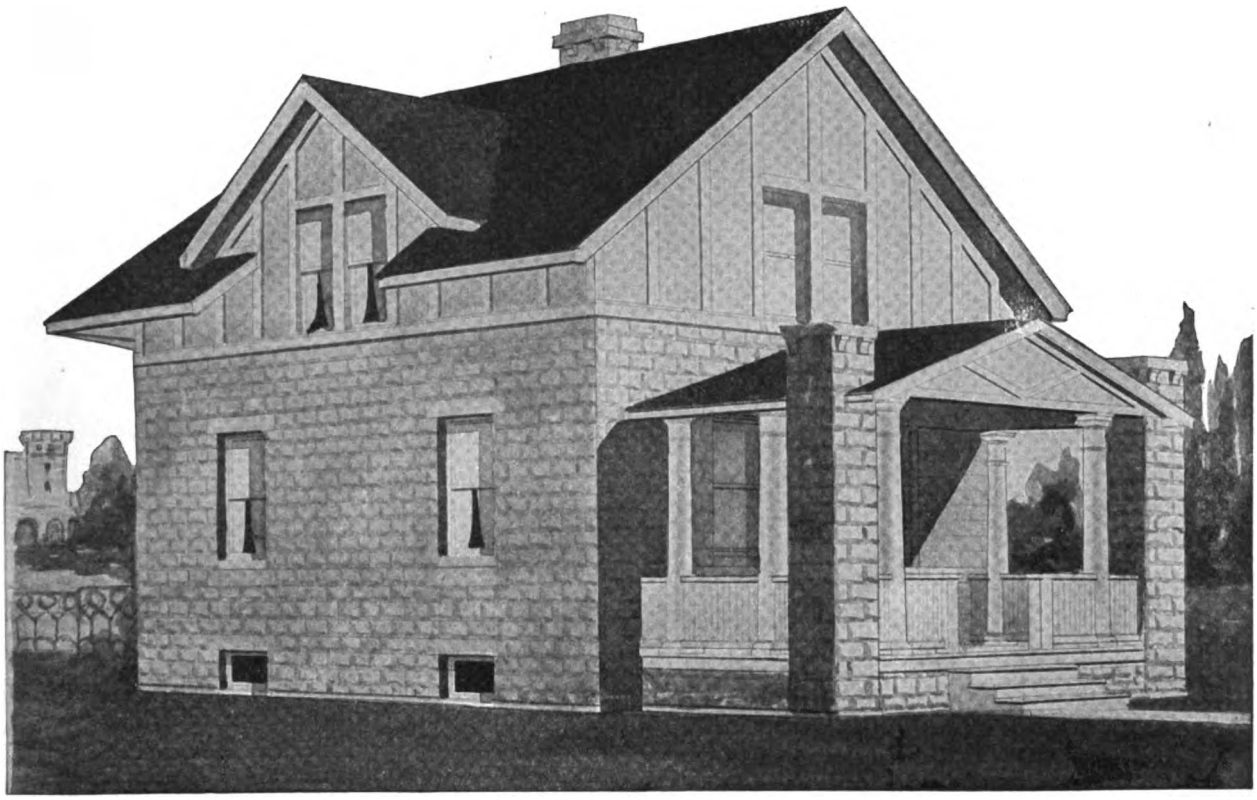


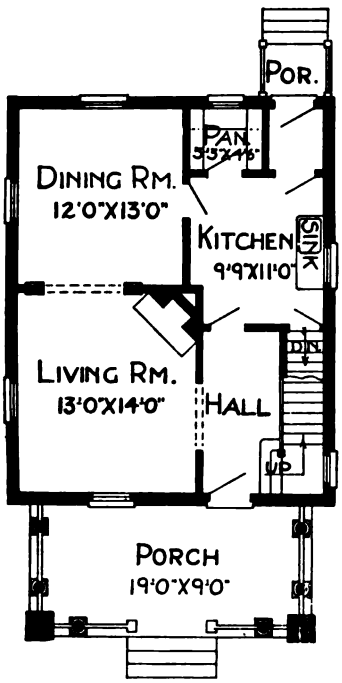
Second Floor Plan

Digitized by Google



Design No. 8218

Size: Width, 24 feet; Length, 30 feet



First Floor Plan

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PRICE

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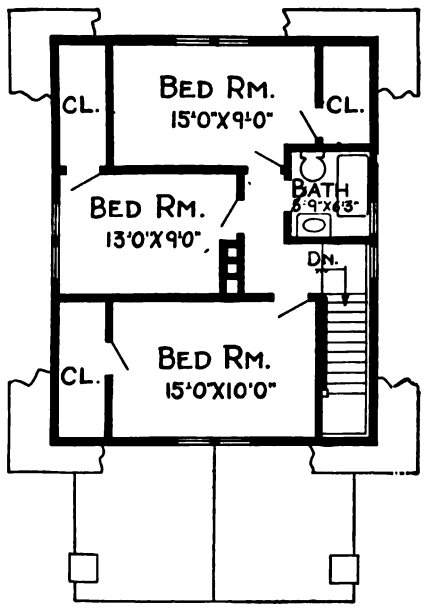
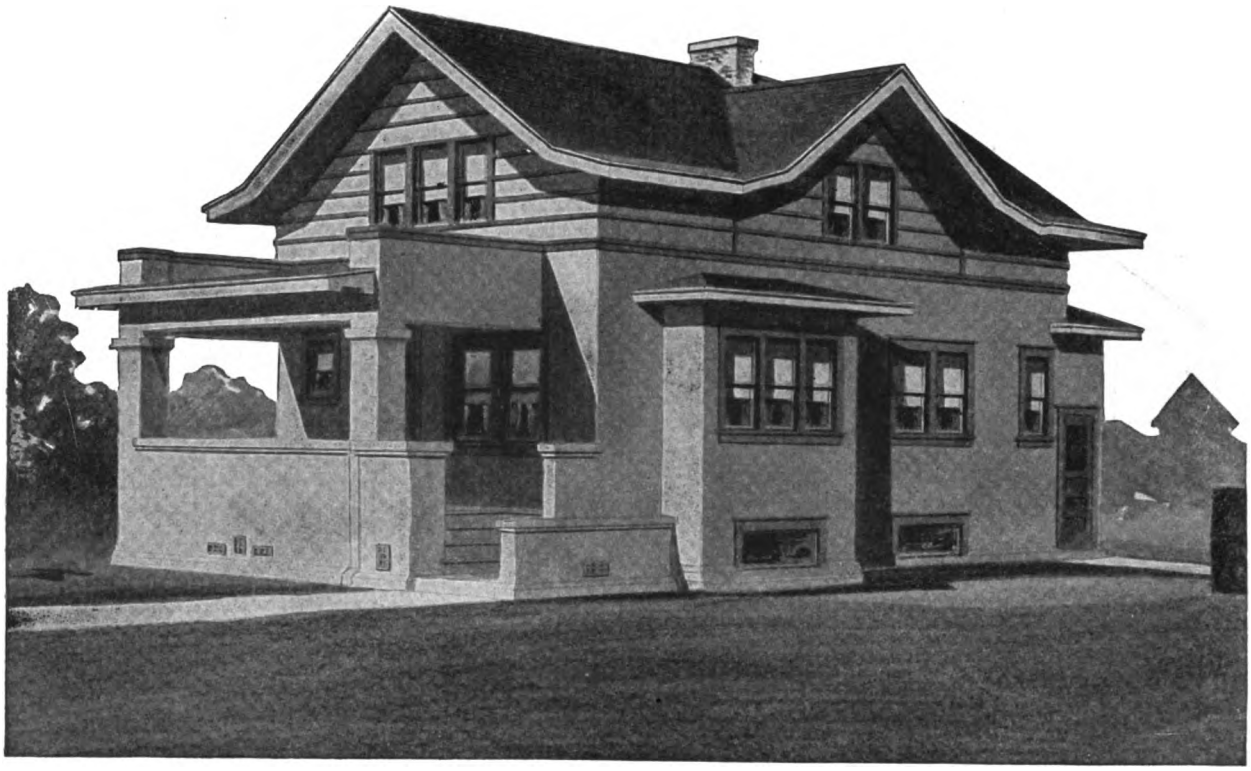


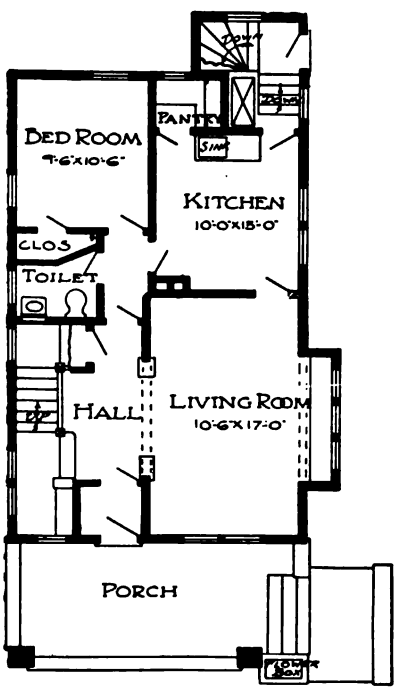
Second Floor Plan

Digitized by Google



Design No. 8199

Size: Width, 23 feet 6 inches; Length, 37 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

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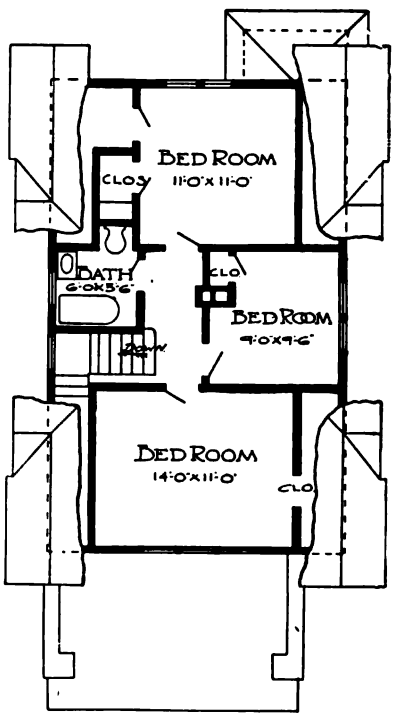
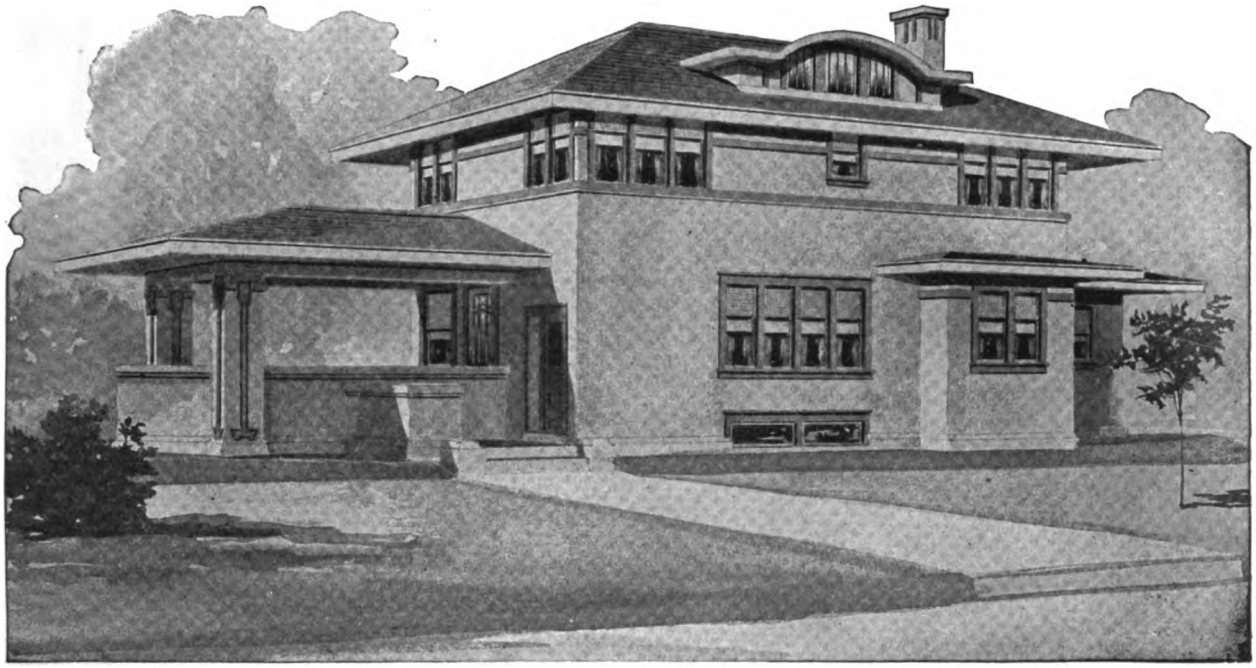


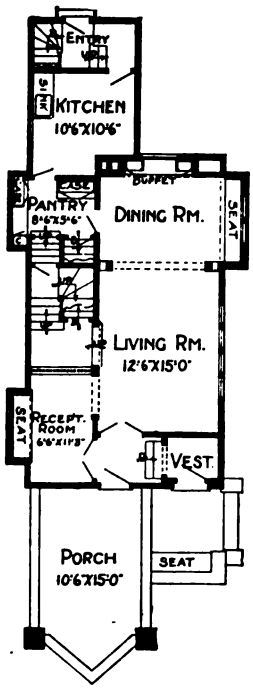
Second Floor Plan

Digitized by Google



Design No. 8215

Size: Width, 25 feet; Length, 48 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

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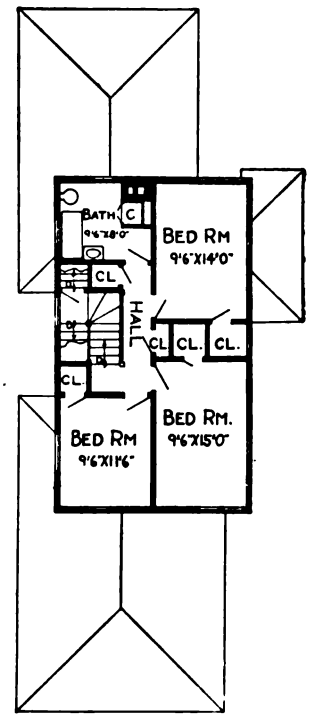
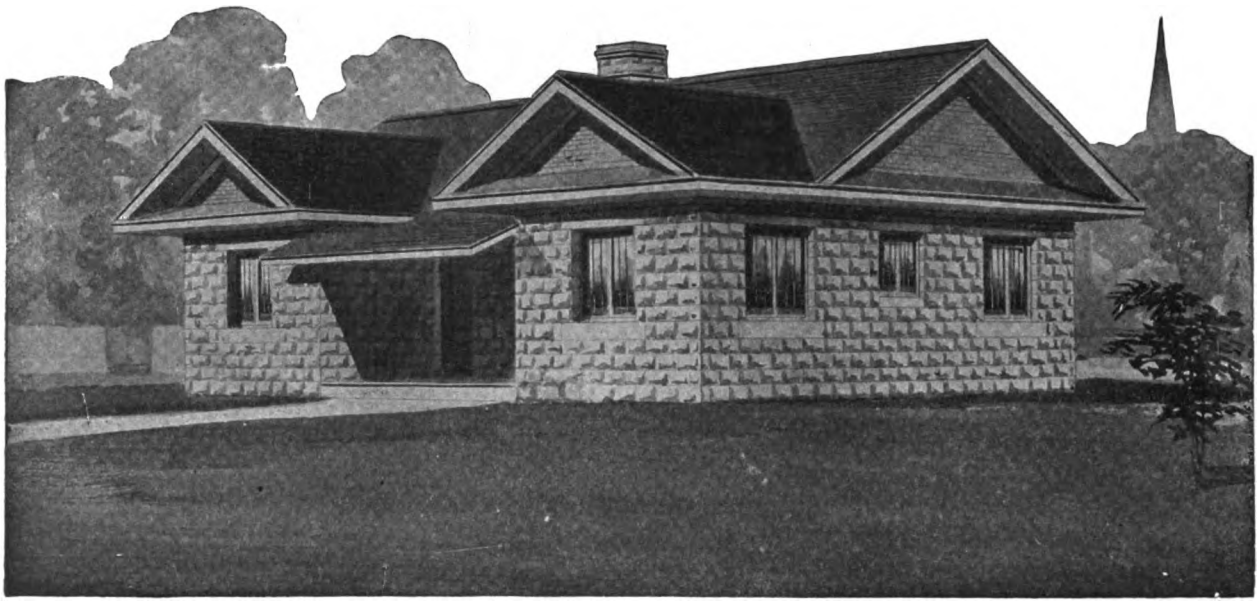


Second Floor Plan

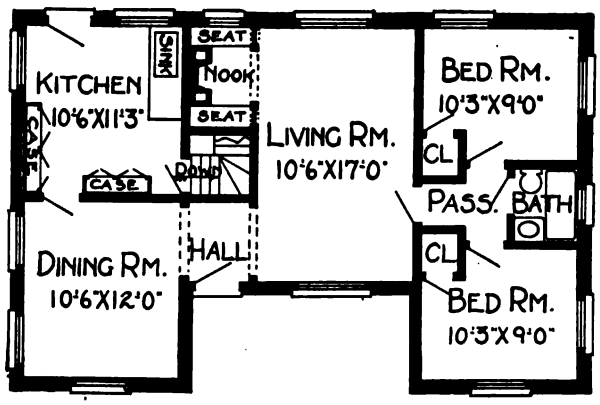
Digitized by Google



Design No. 8225

Size: Width, 38 feet 4 inches; Length, 25 feet 4 inches

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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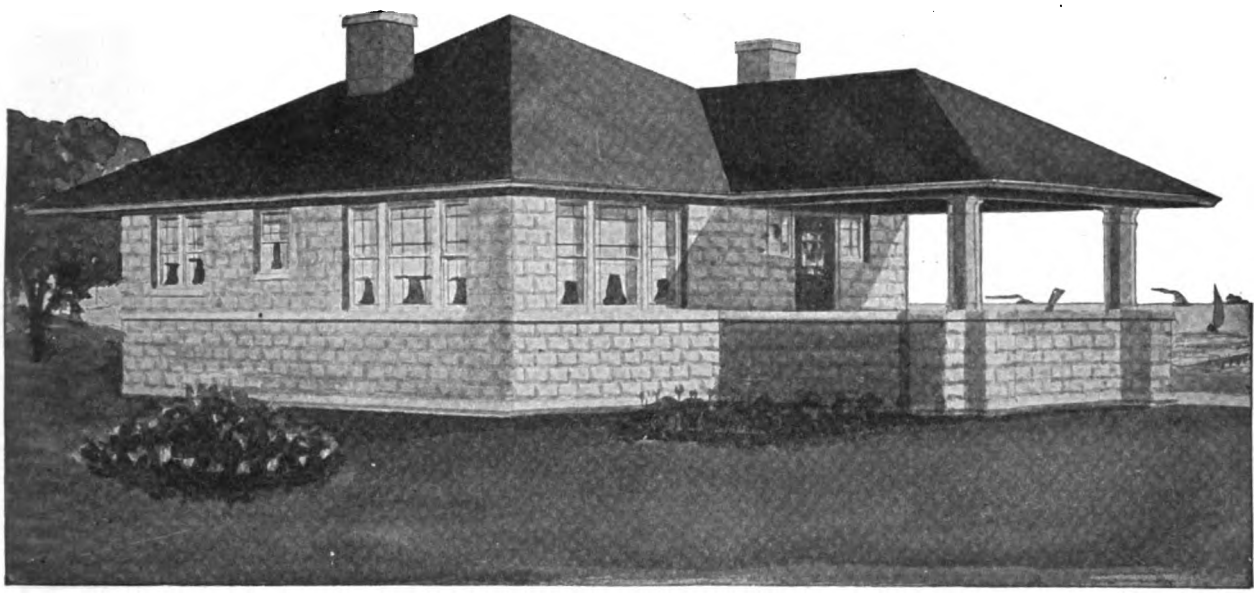
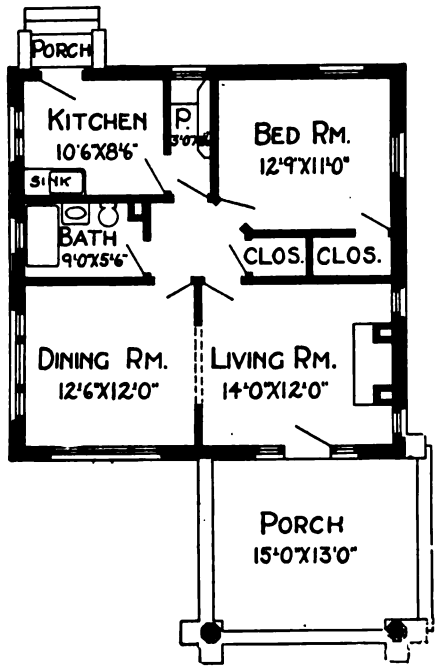
Digitized by Google



Design No. 8219

Size: Width, 29 feet 4 inches; Length, 29 feet 4 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

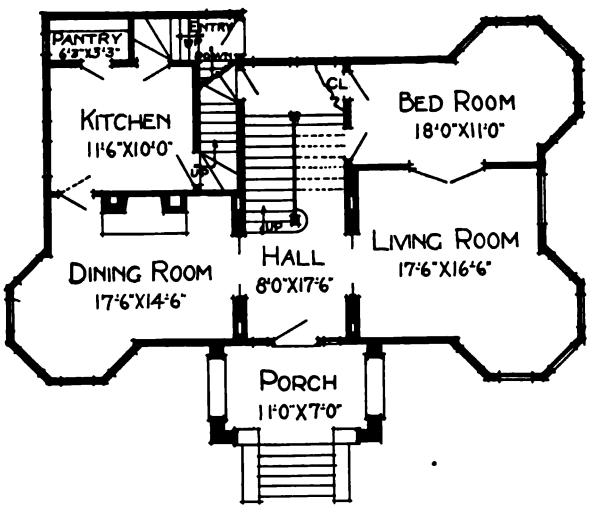
ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

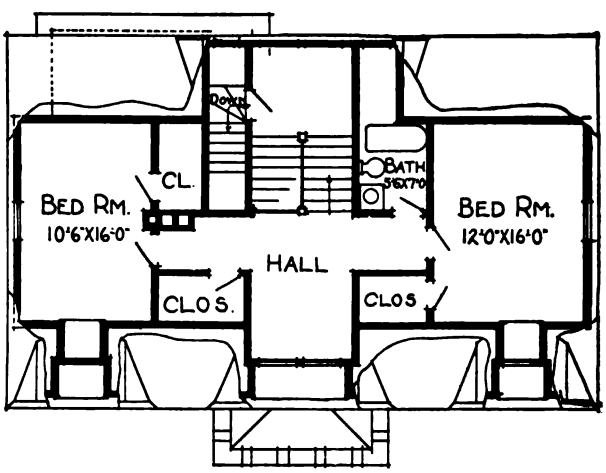
Digitized by Google

Design No. 8246

Size: Width, 46 feet; Length, 29 feet



First Floor Plan



Second Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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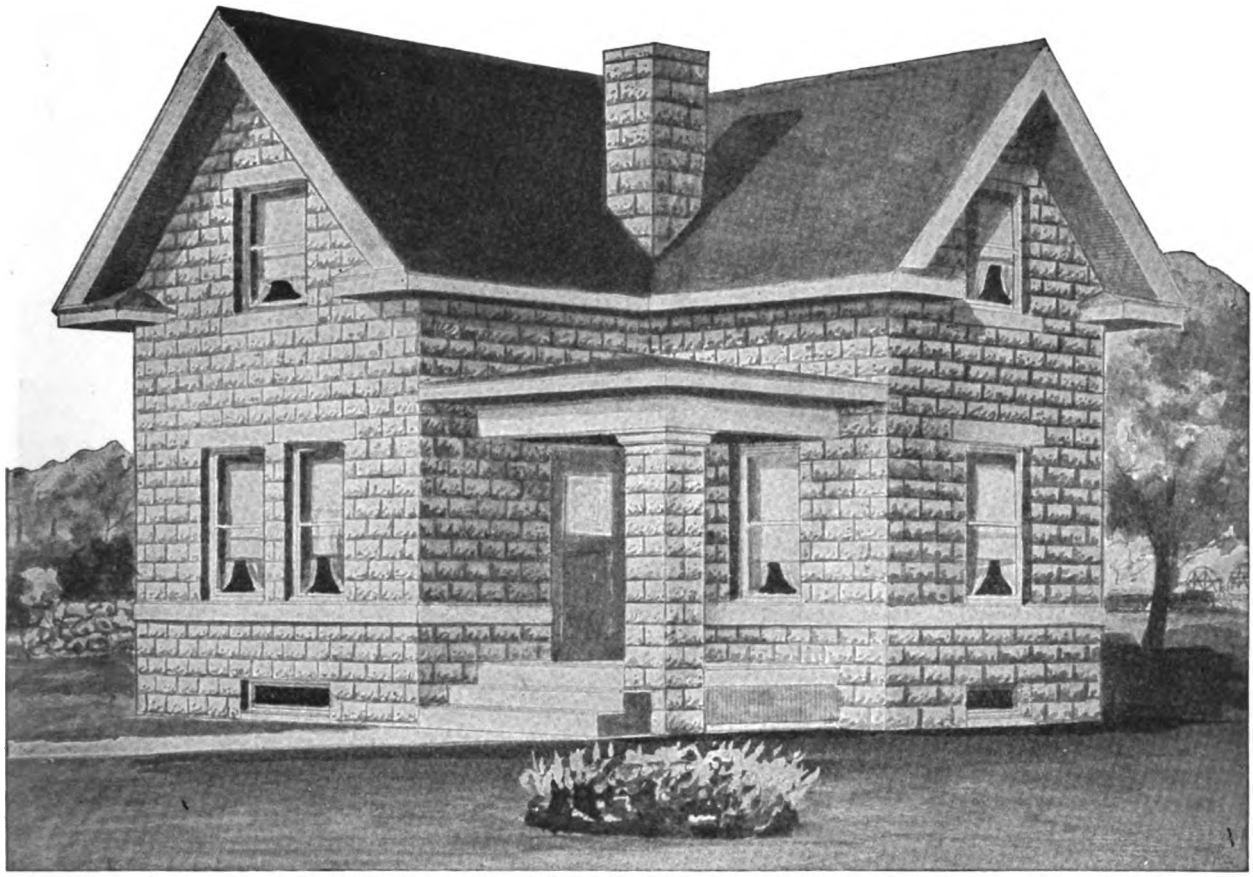
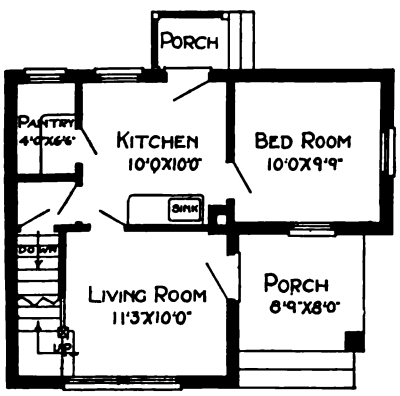
Digitized by Google



Design No. 8210

Size: Width, 26 feet 8 inches; Length, 22 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

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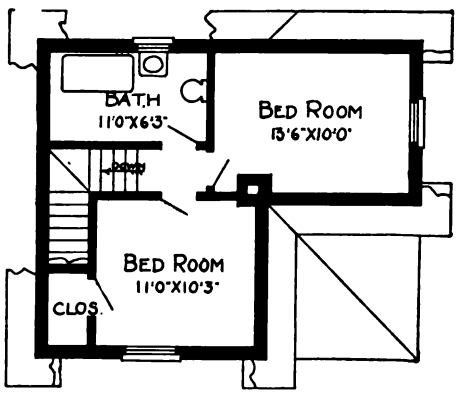
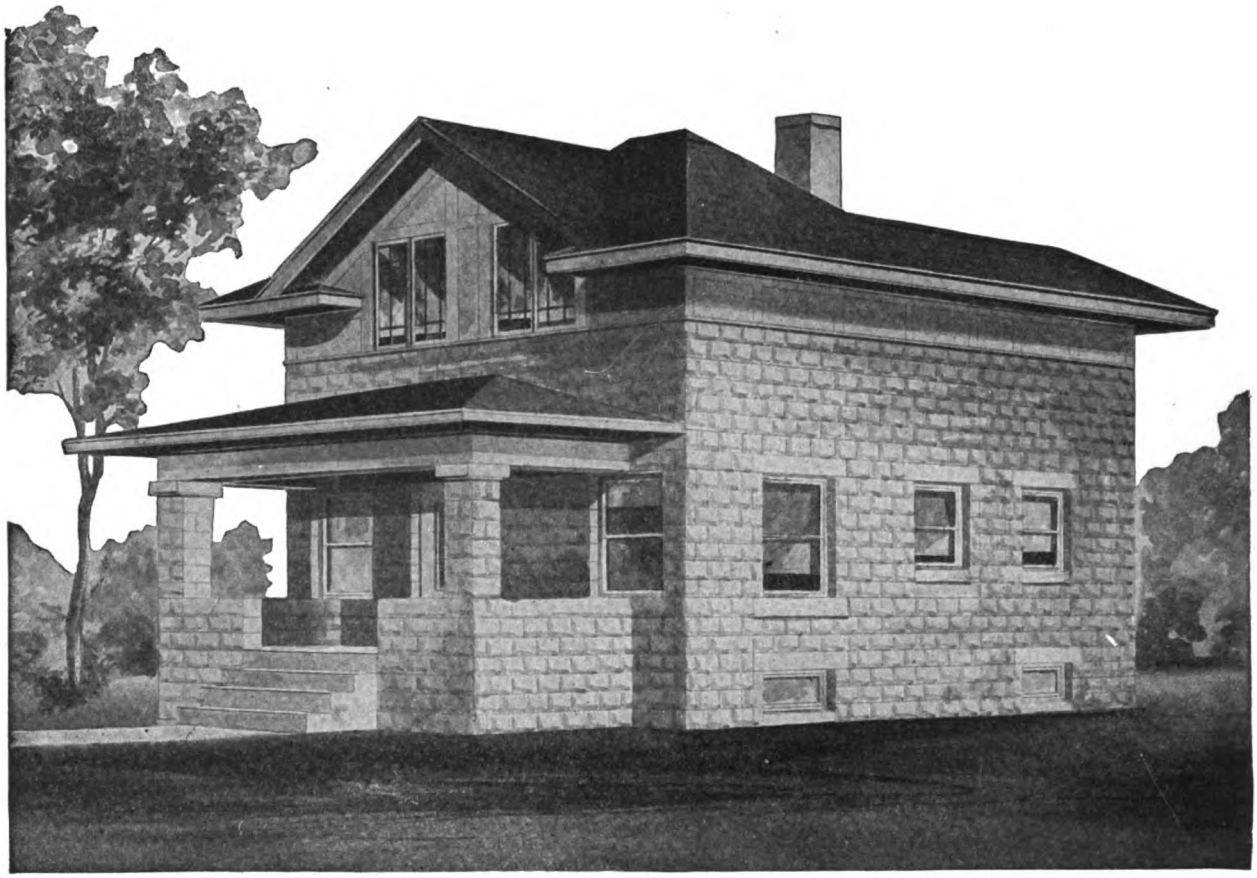


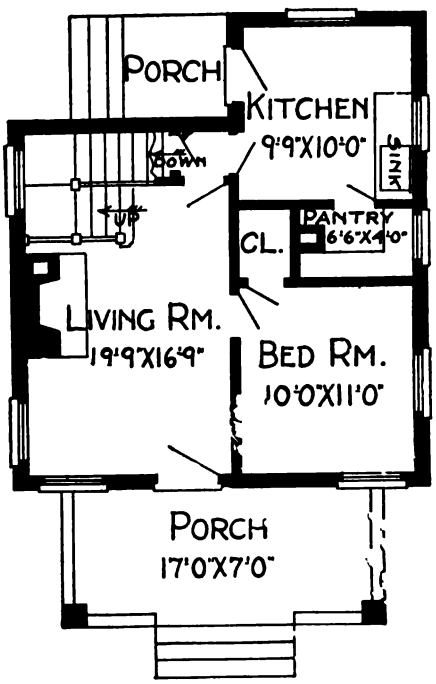
Second Floor Plan

Digitized by Google



Design No. 8224

Size: Width, 24 feet; Length, 27 feet 4 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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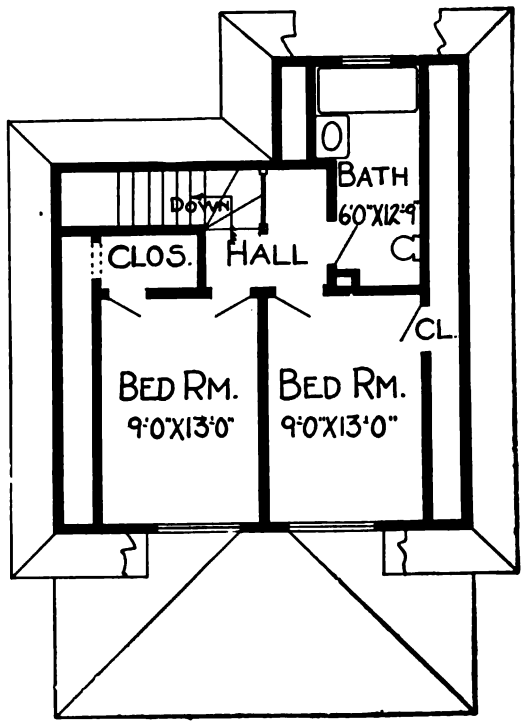
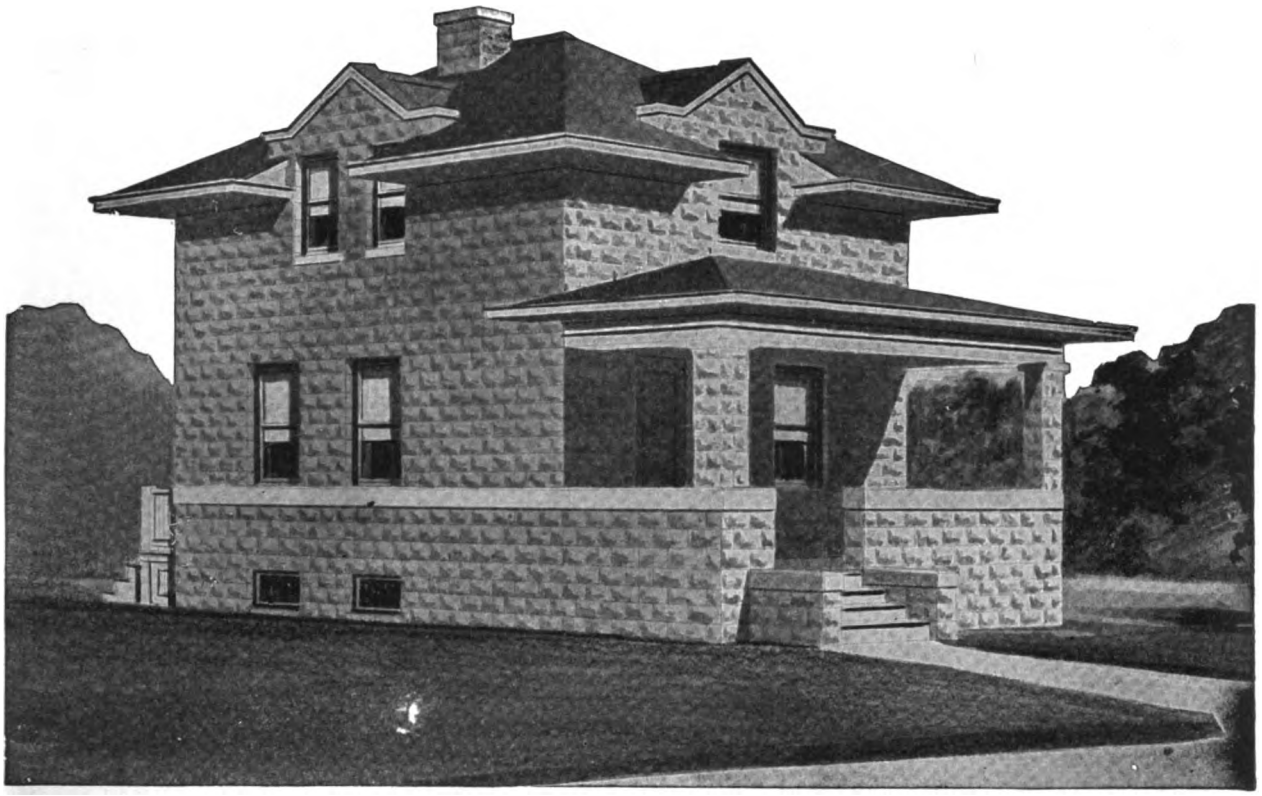


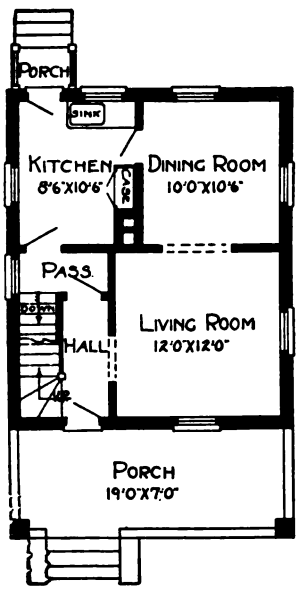
Second Floor Plan

Digitized by Google



Design No. 8197

Size: Width, 20 feet 8 inches; Length, 24 feet 8 inches



First Floor Plan

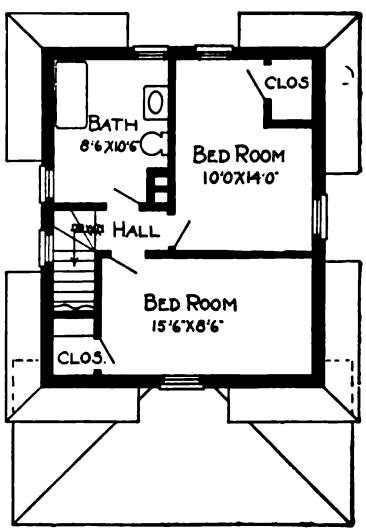
Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

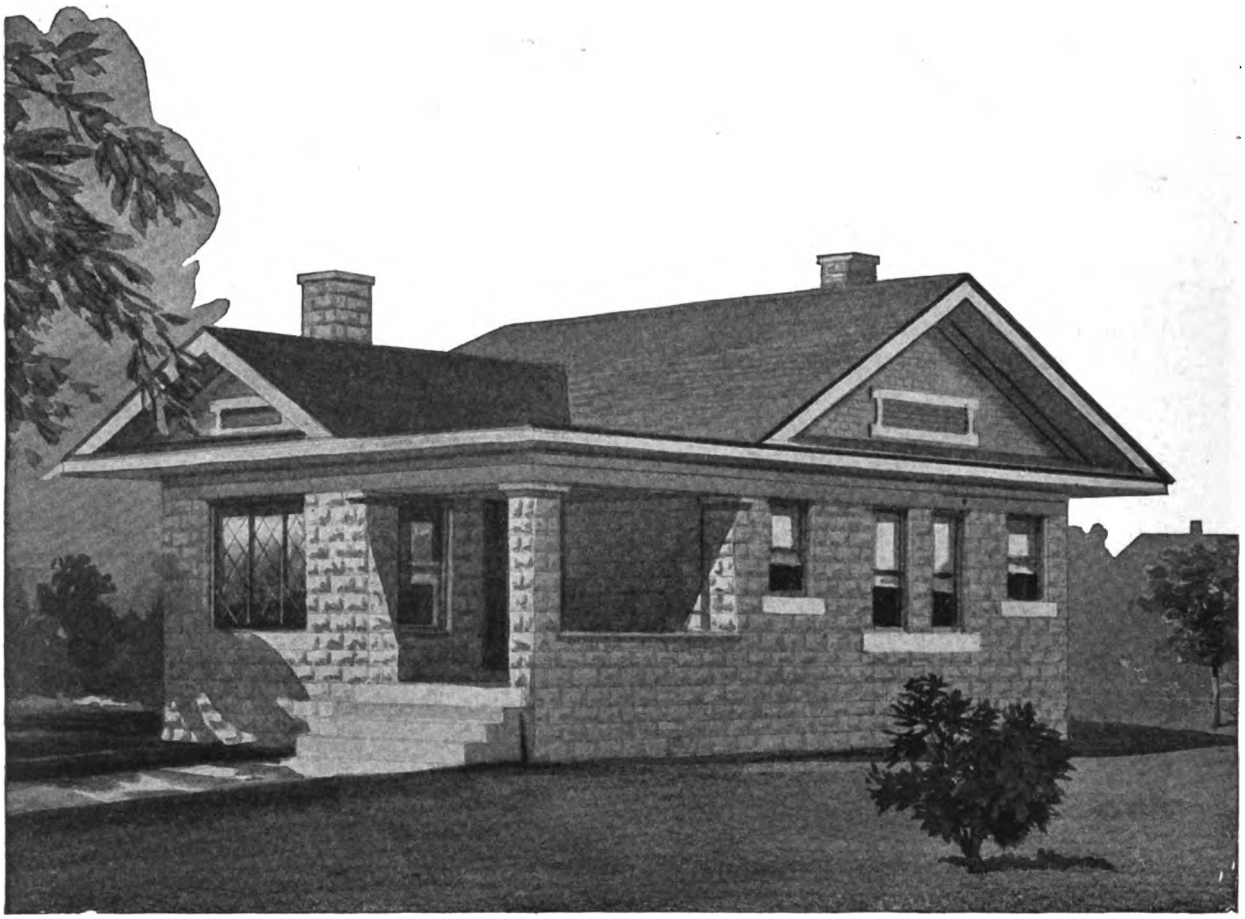
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



Second Floor Plan

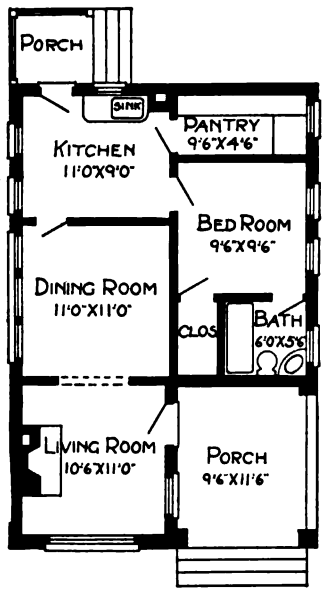
Digitized by Google



Design No. 8202

Size: Width, 22 feet 4 inches; Length, 33 feet 8 inches

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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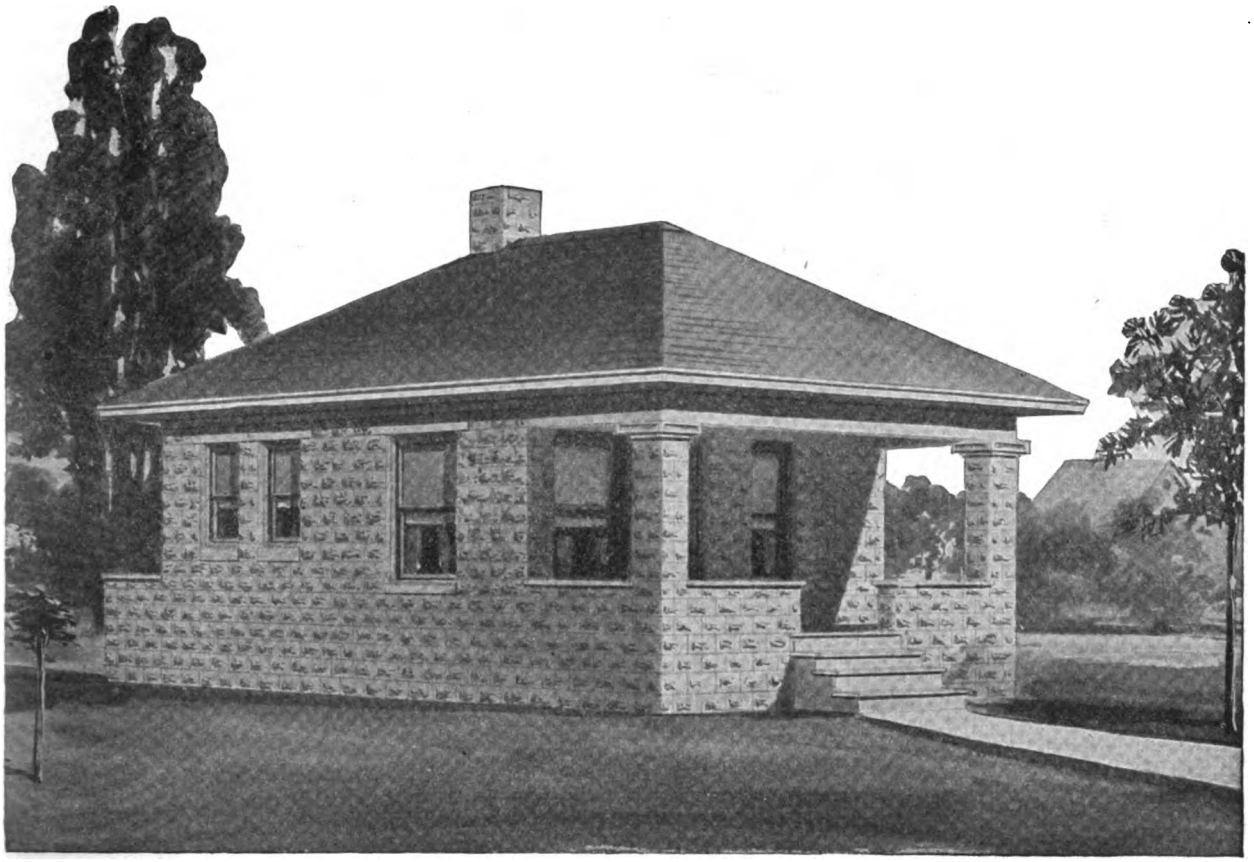
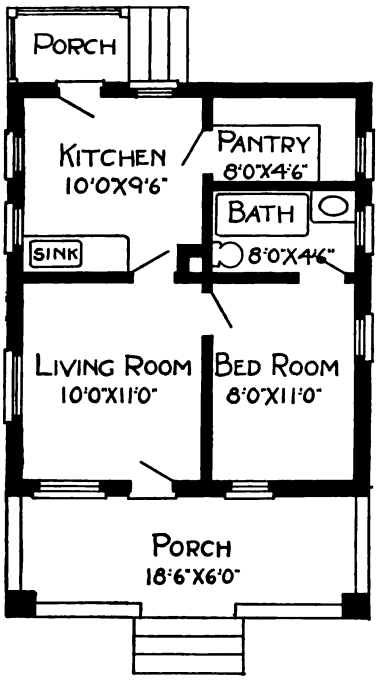
Digitized by Google



Design No. 8201

Size: Width, 20 feet; Length, 22 feet

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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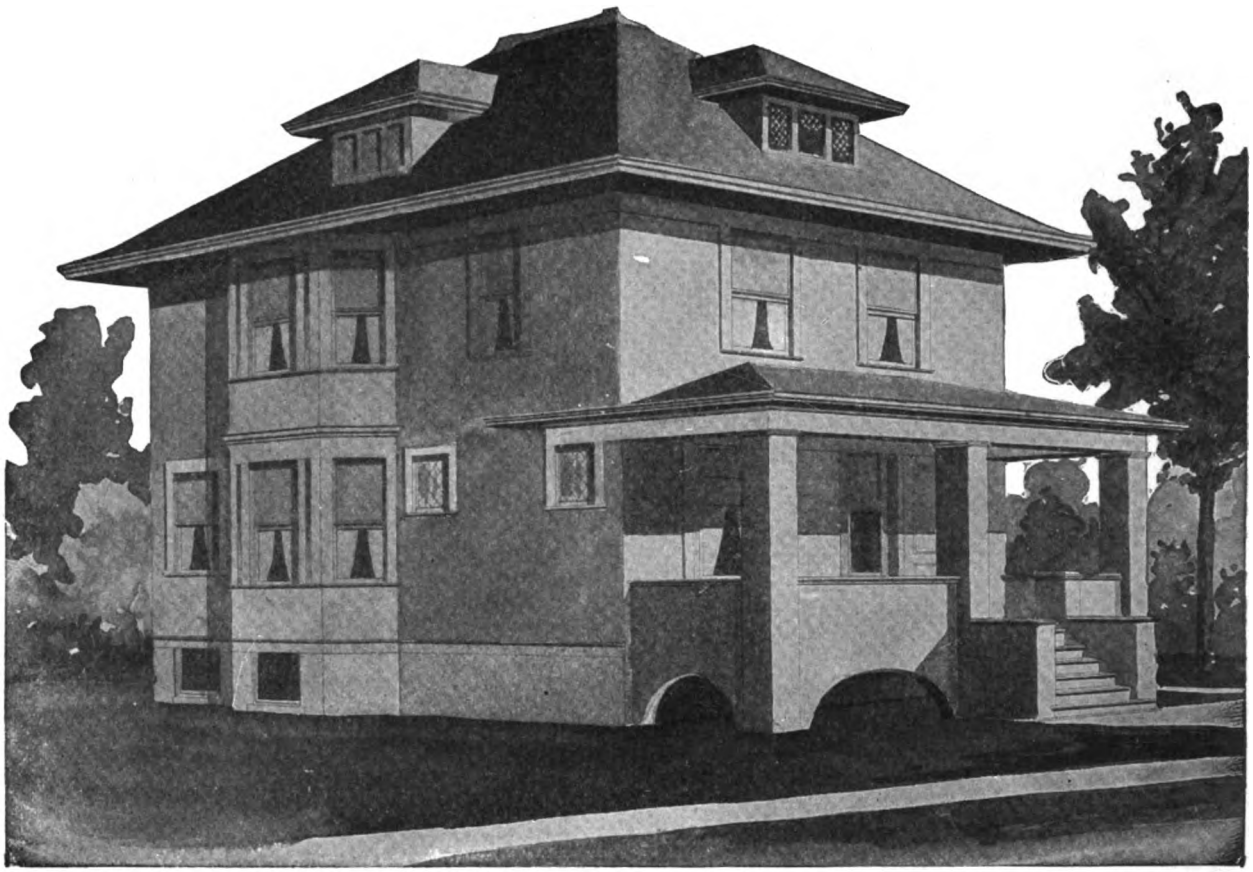
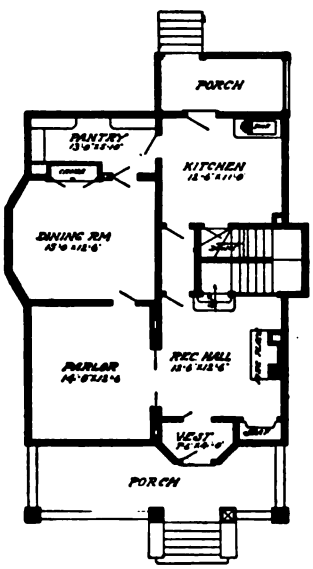
Digitized by Google



Design No. 8020

Size: Width, 31 feet; Length, 34 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY FIFTEEN DOLLARS

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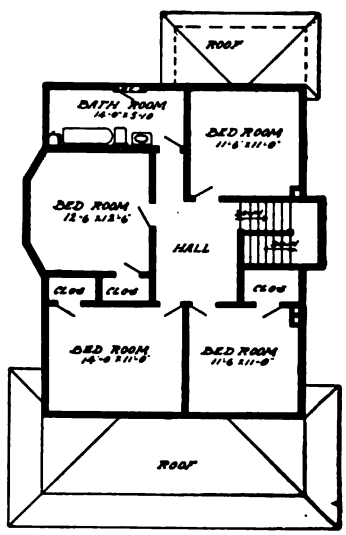
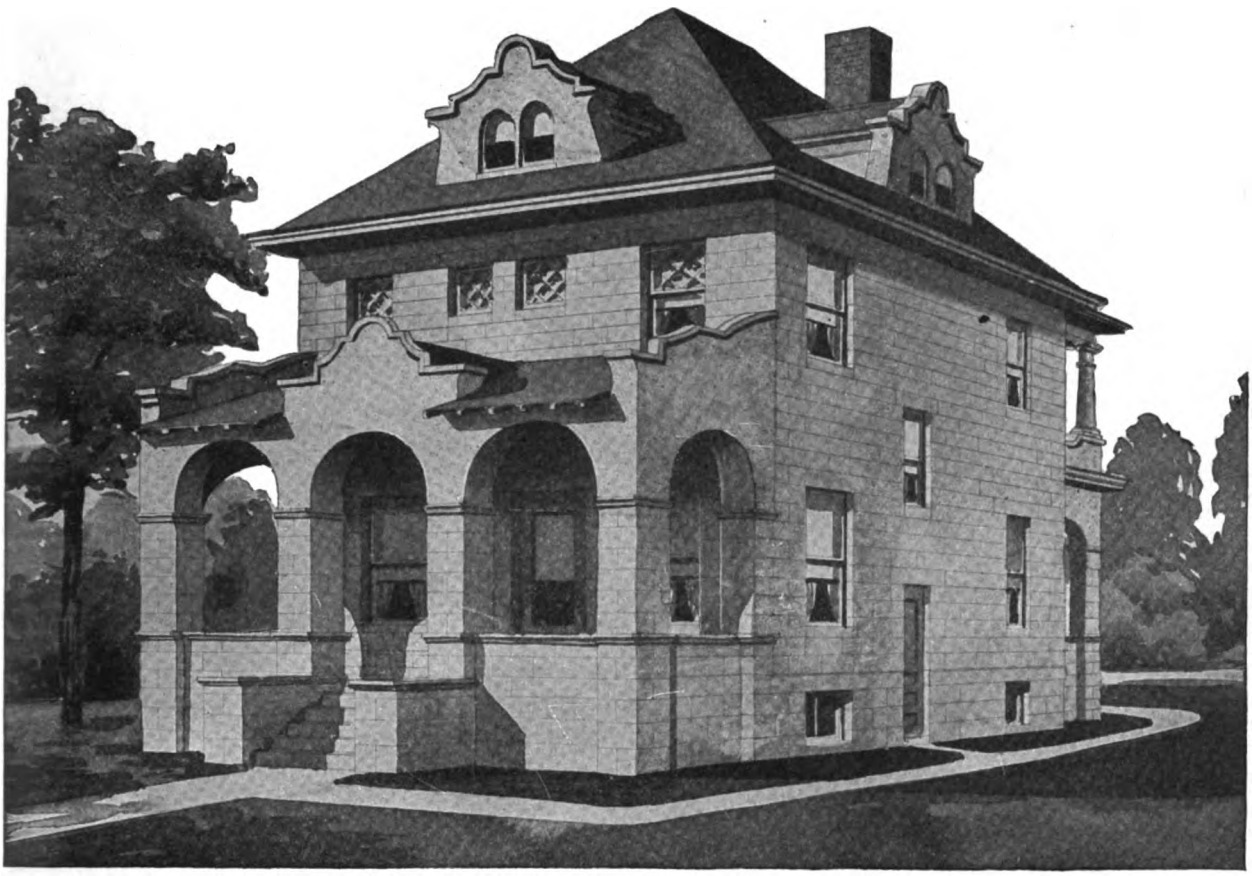


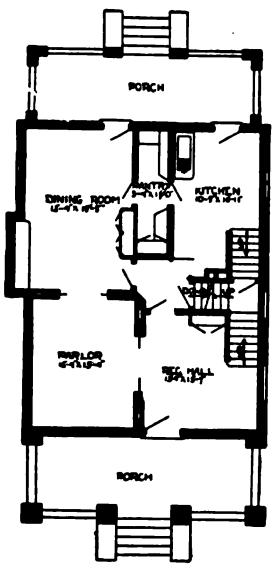
Second Floor Plan

Digitized by Google



Design No. 8043

Size: Width, 28 feet; Length, 33 feet 8 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

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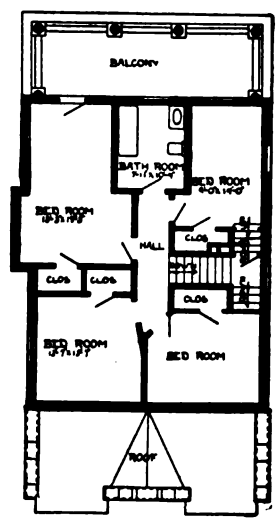
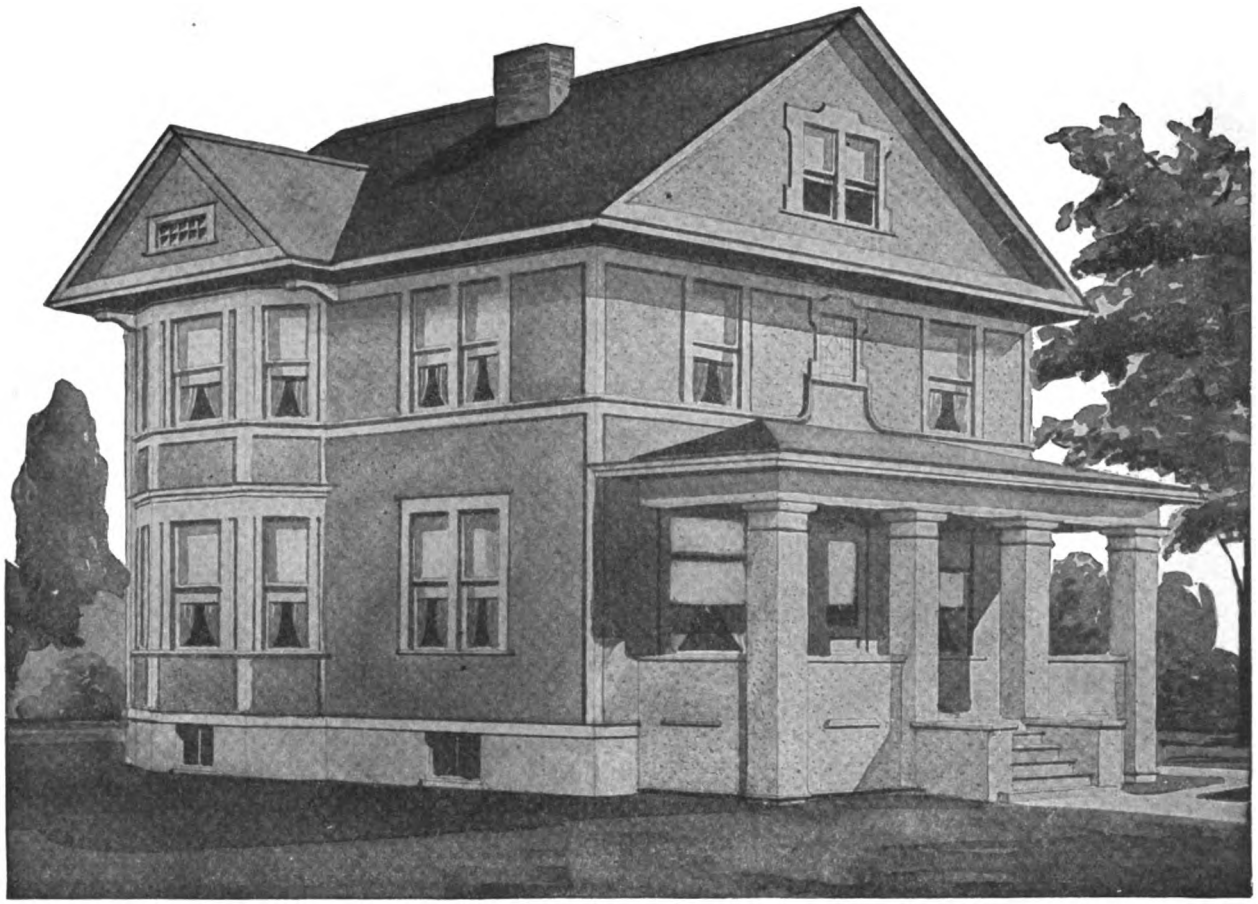


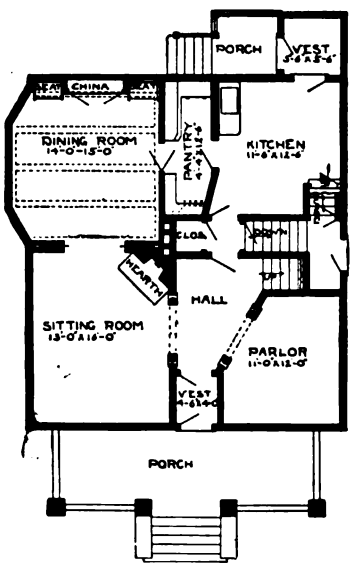
Second Floor Plan

Digitized by Google



Design No. 8141

Size: Width, 31 feet 6 inches; Length, 33 feet



First Floor Plan

Blue prints consist of basement plans; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

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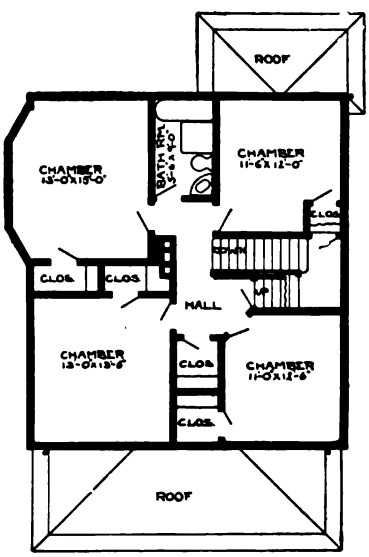
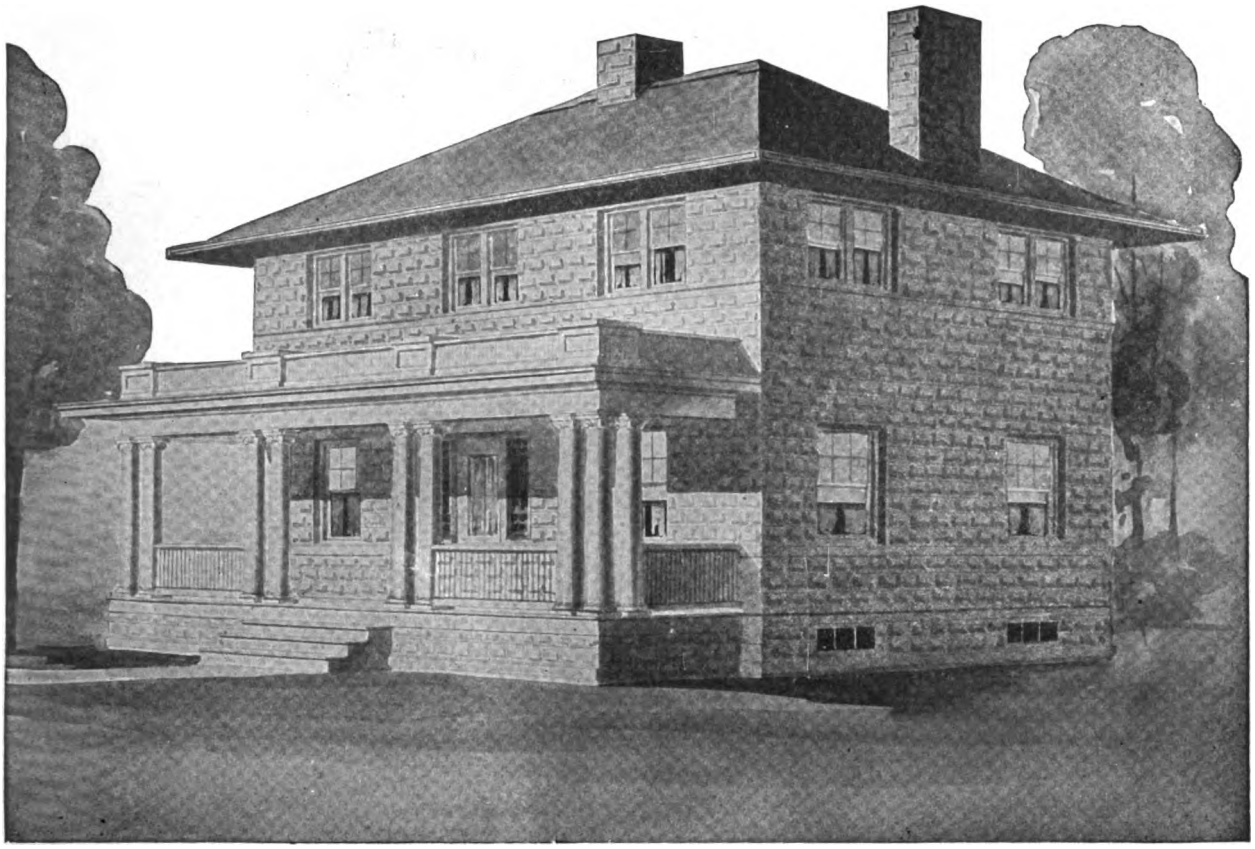


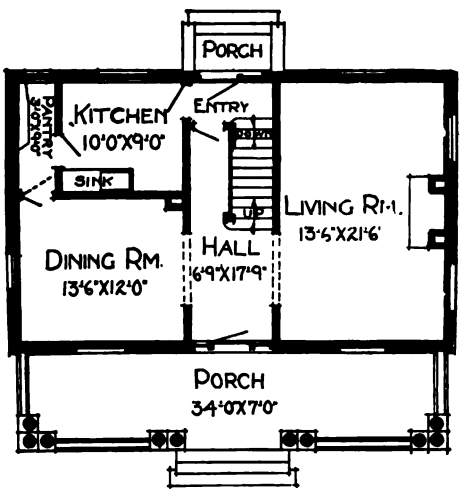
Second Floor Plan

Digitized by Google



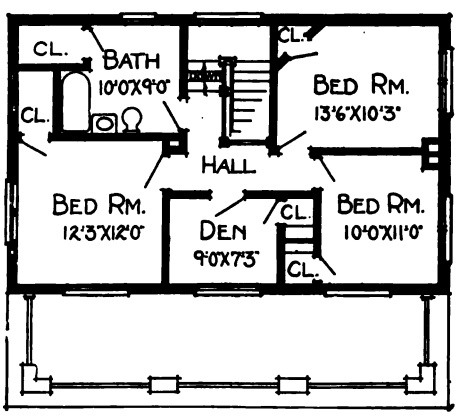
Design No. 8248

Size: Width, 36 feet; Length, 23 feet 4 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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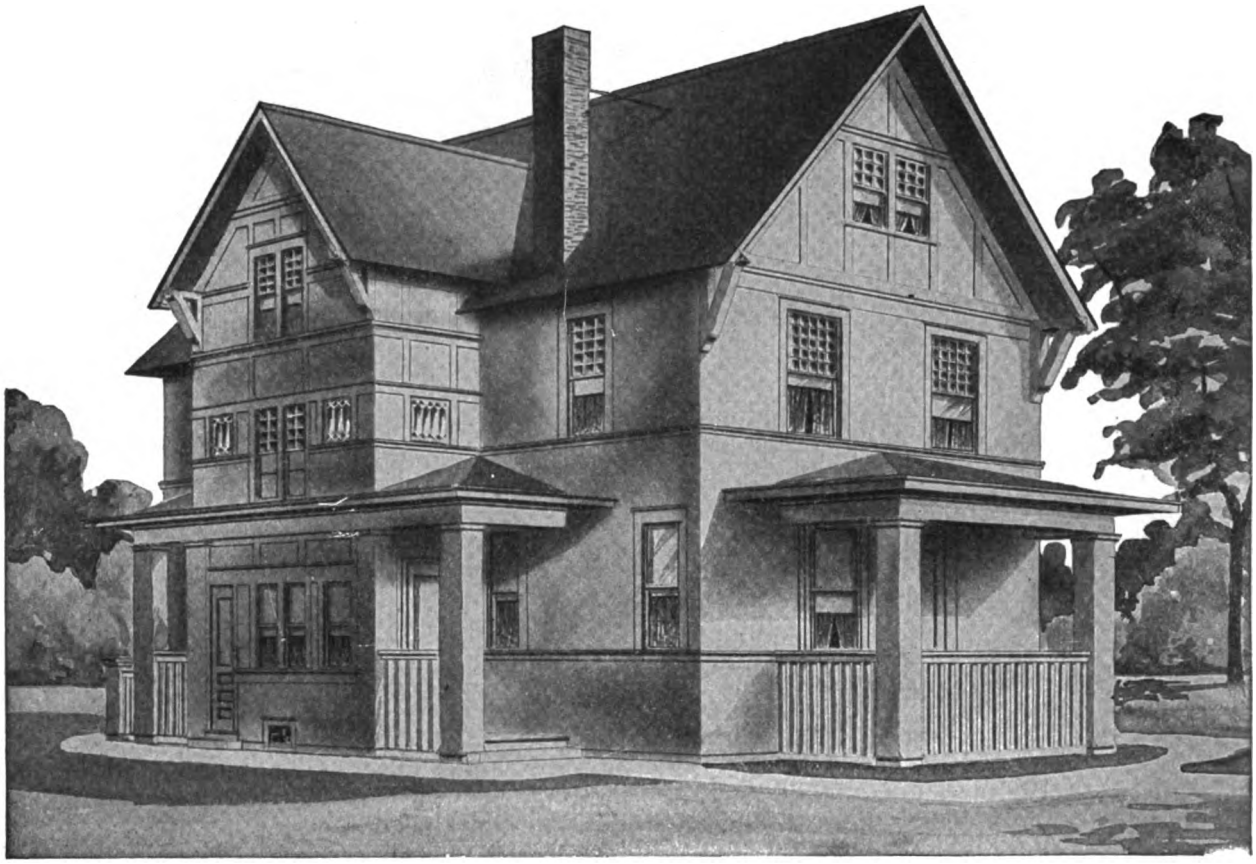
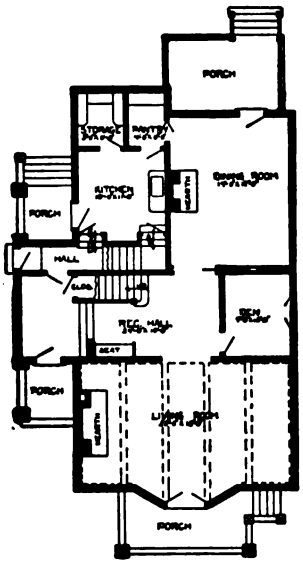
Digitized by Google



Design No. 8077

Size: Width, 34 feet; Length, 48 feet 8 inches



First Floor Plan

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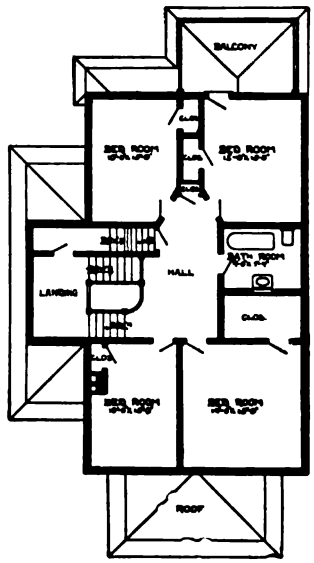
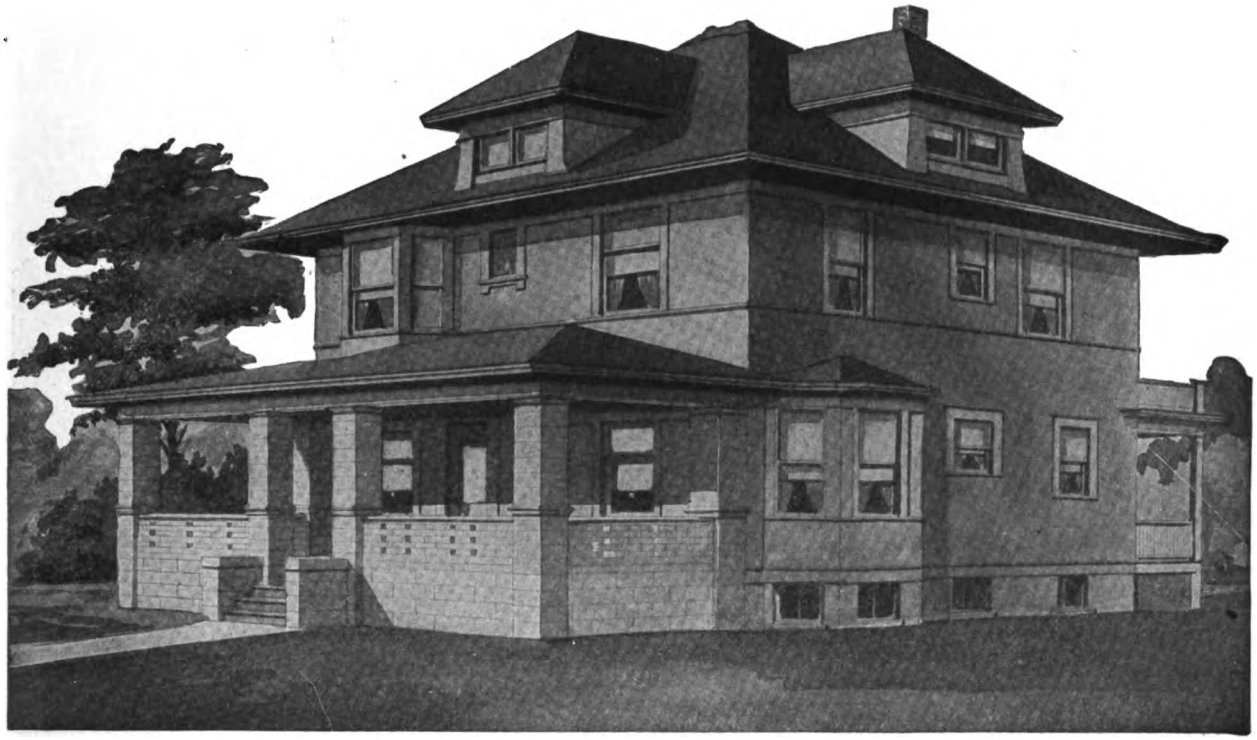


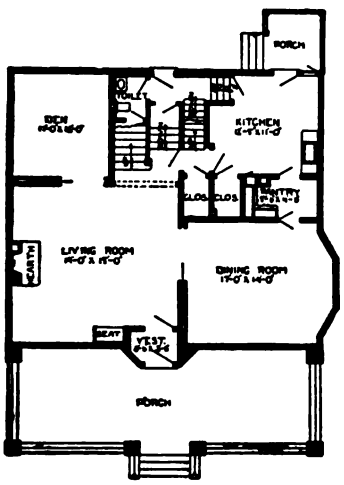
Second Floor Plan

Digitized by Google



Design No. 8046

Size: Width, 38 feet; Length, 32 feet



First Floor Plan

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PRICE

of Blue Prints, together with a complete set of typewritten specifications

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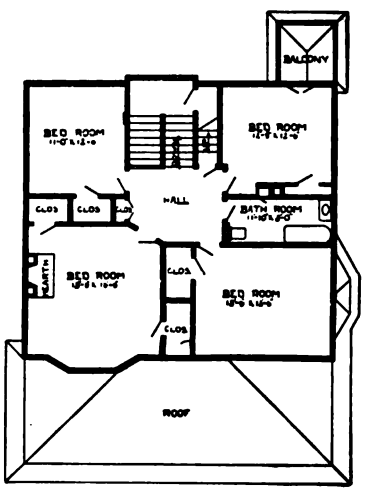
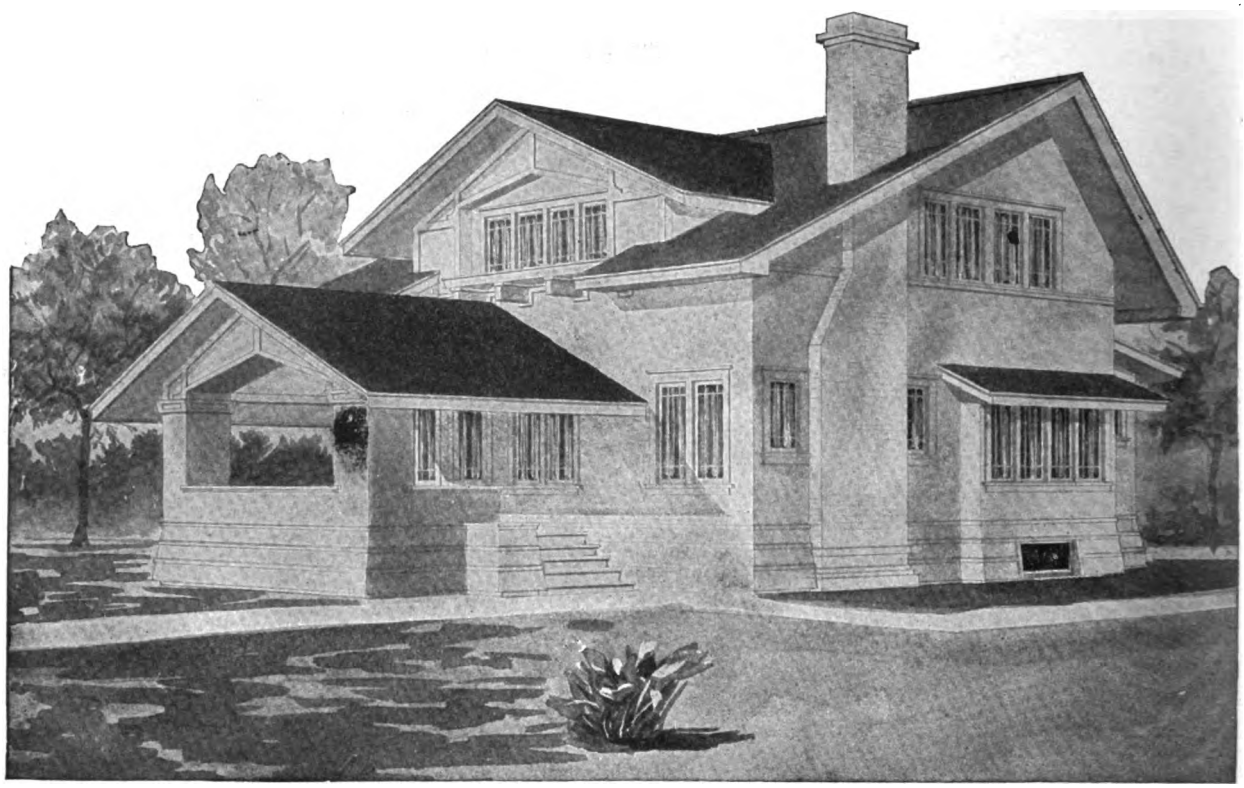


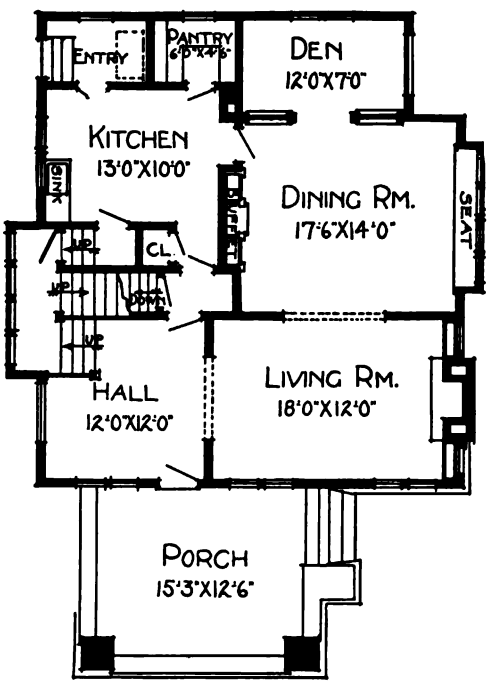
Second Floor Plan

Digitized by Google



Design No. 8241

Size: Width, 35 feet 6 inches; Length, 35 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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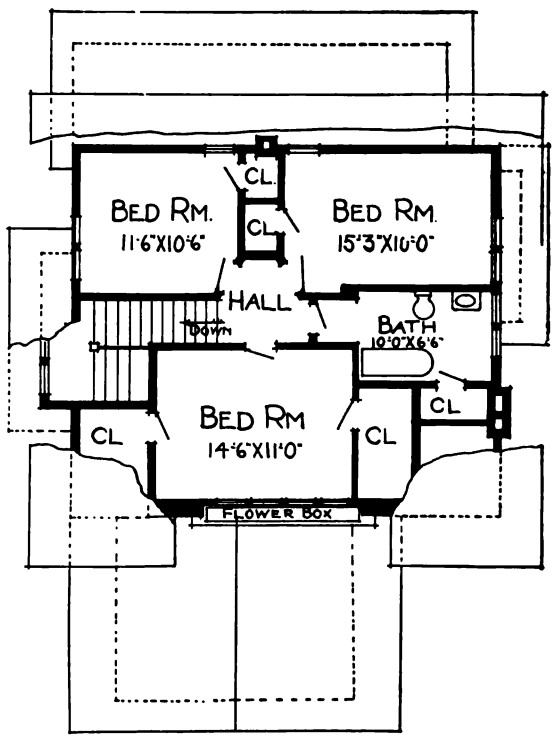
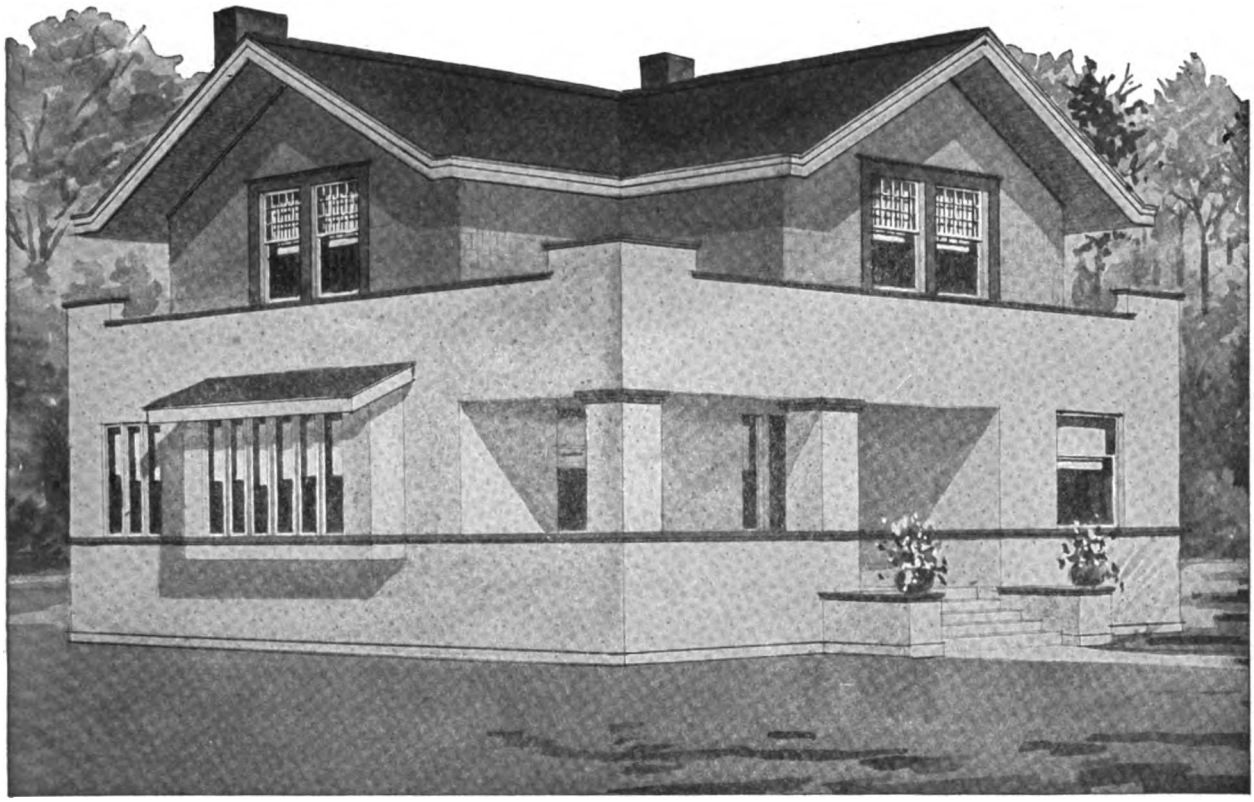


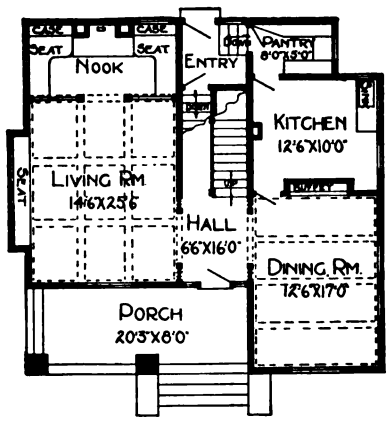
Second Floor Plan

Digitized by Google



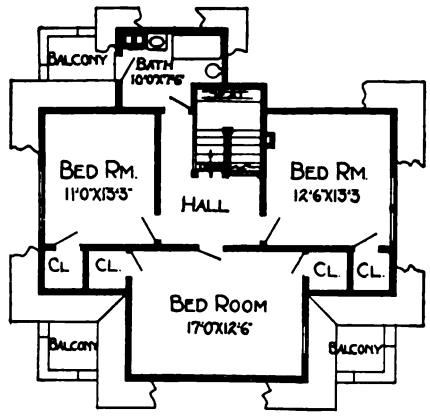
Design No. 8324

Size: Width, 37 feet 6 inches; Length, 35 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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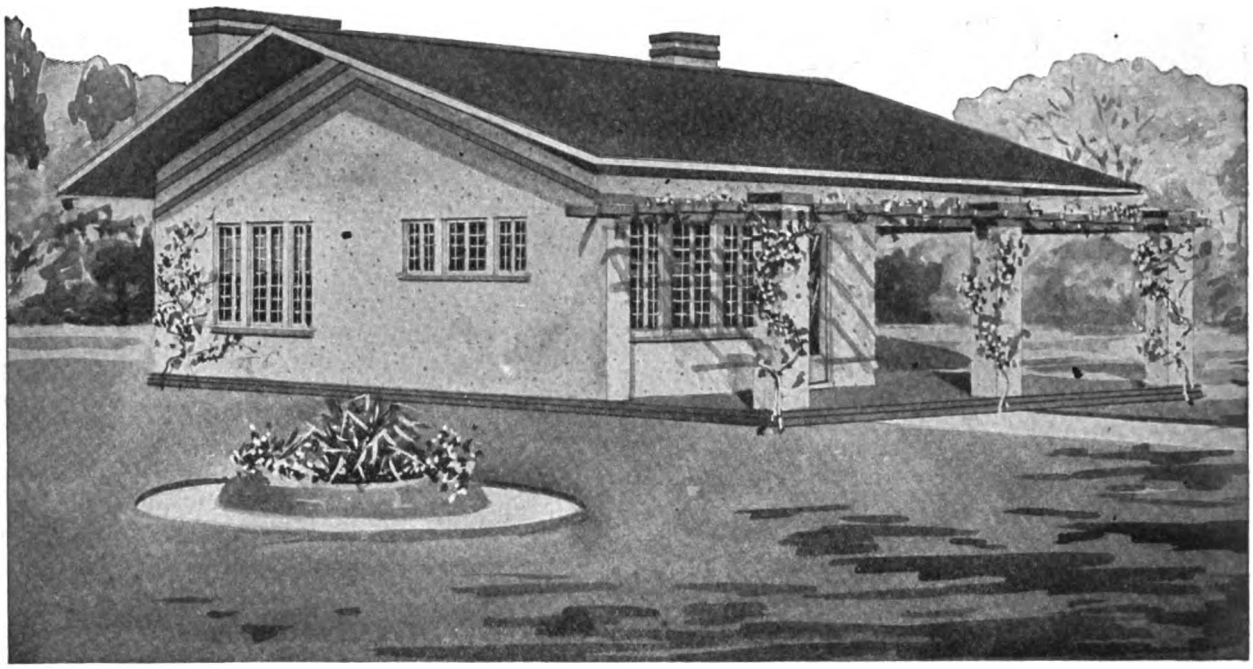
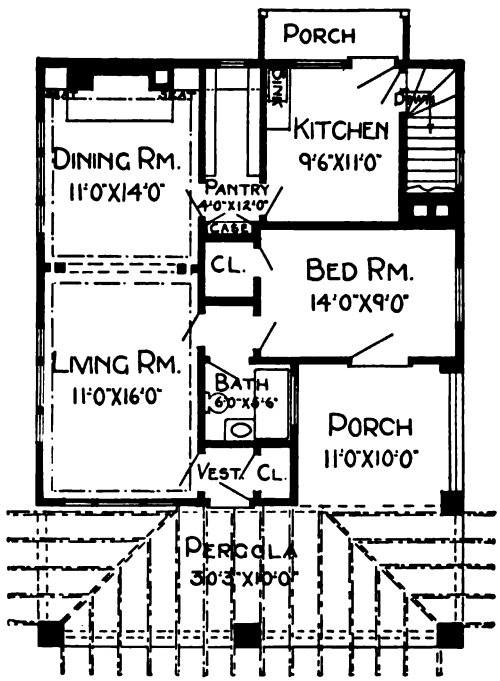
Digitized by Google



Design No. 8329

Size: Width, 30 feet 6 inches; Length, 31 feet 6 inches

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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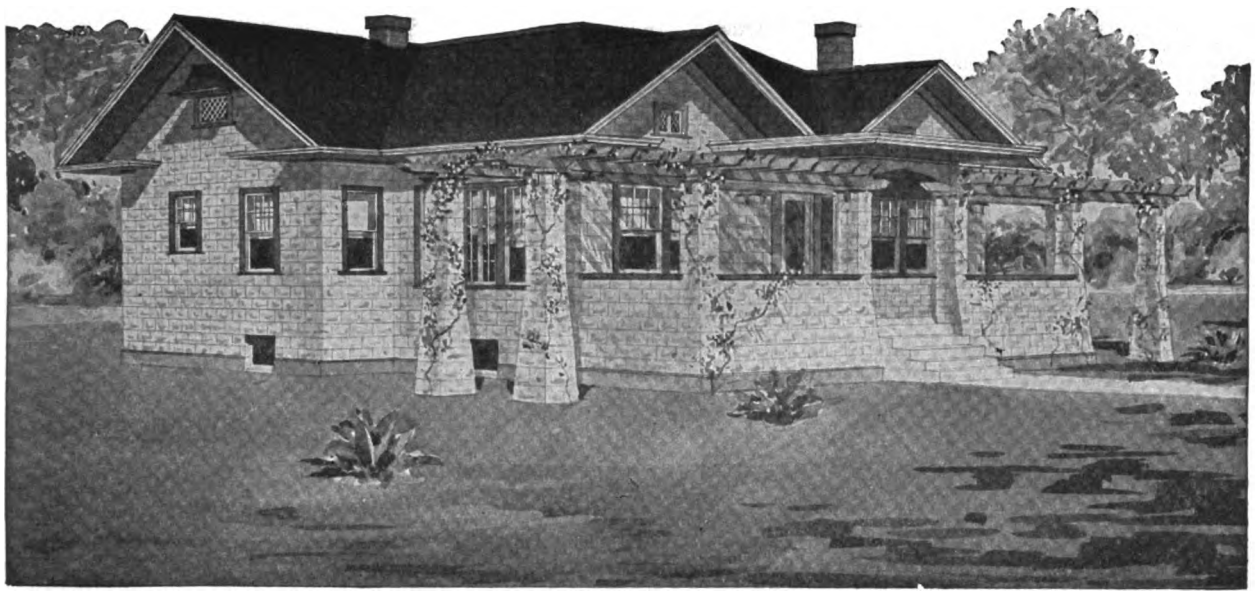
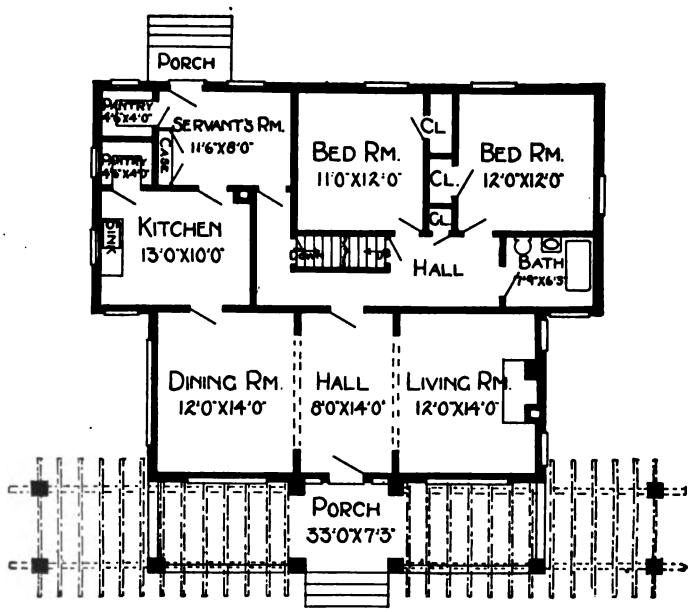
Digitized by Google



Design No. 8302

Size: Width, 44 feet; Length, 34 feet 6 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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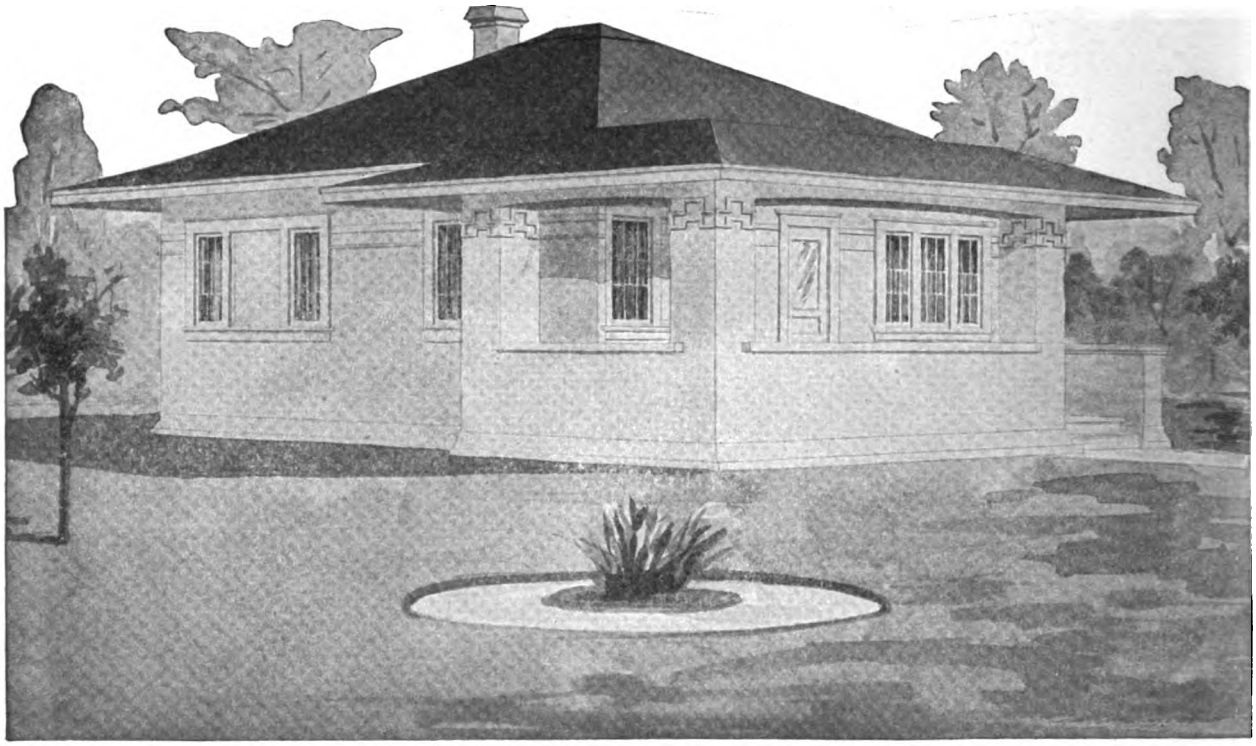
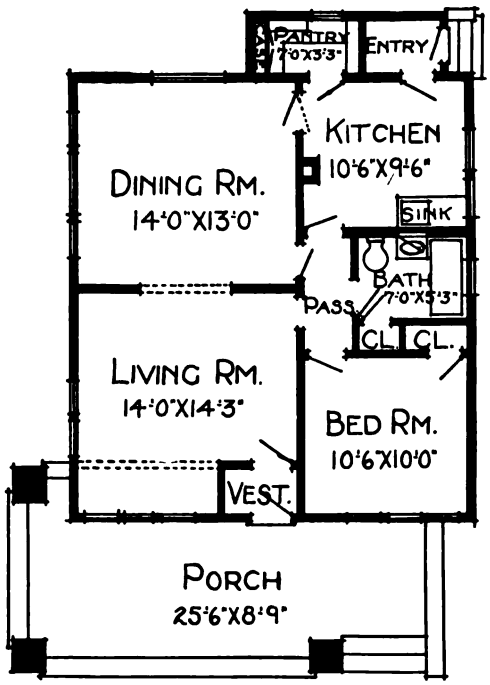
Digitized by Google



Design No. 8261

Size Width, 26 feet; Length, 32 feet 8 inches

Blue prints consist of foundation plan; floor plan; front, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan
124

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

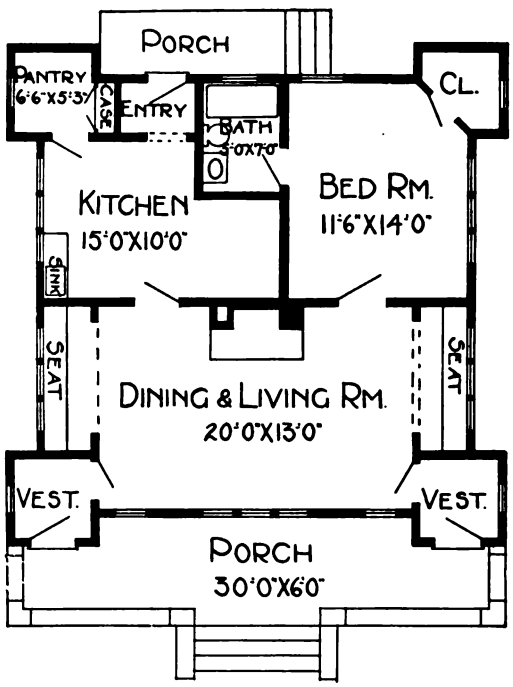
We mail Plans and Specifications the same day order is received.

Digitized by Google

Design No. 8332

Size: Width, 32 feet; Length, 32 feet

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan
125

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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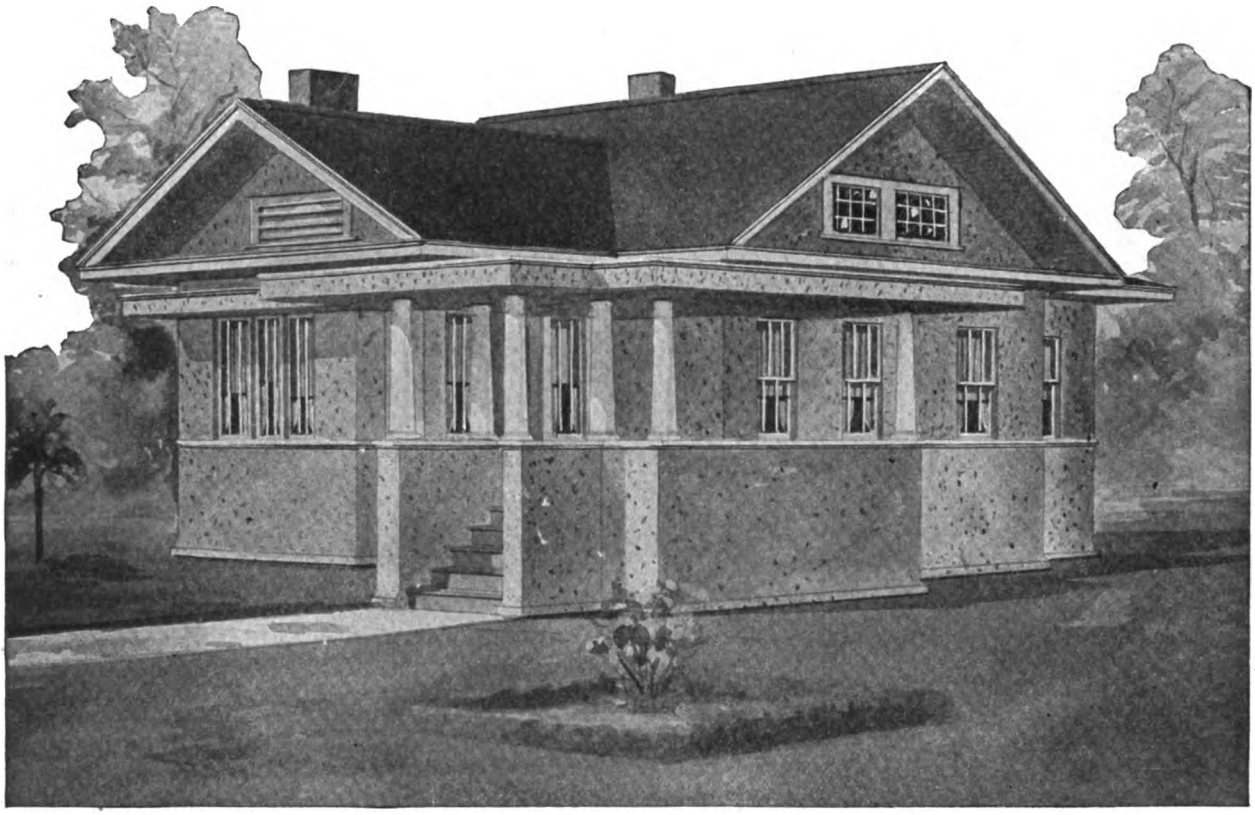
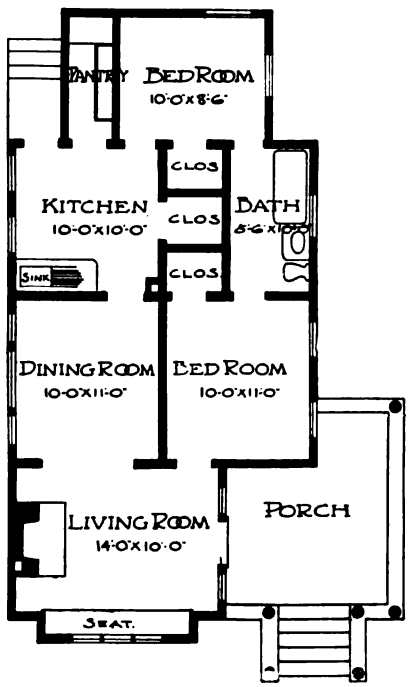
Digitized by Google



Design No. 8193

Size: Width, 21 feet 6 inches; Length, 43 feet 6 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

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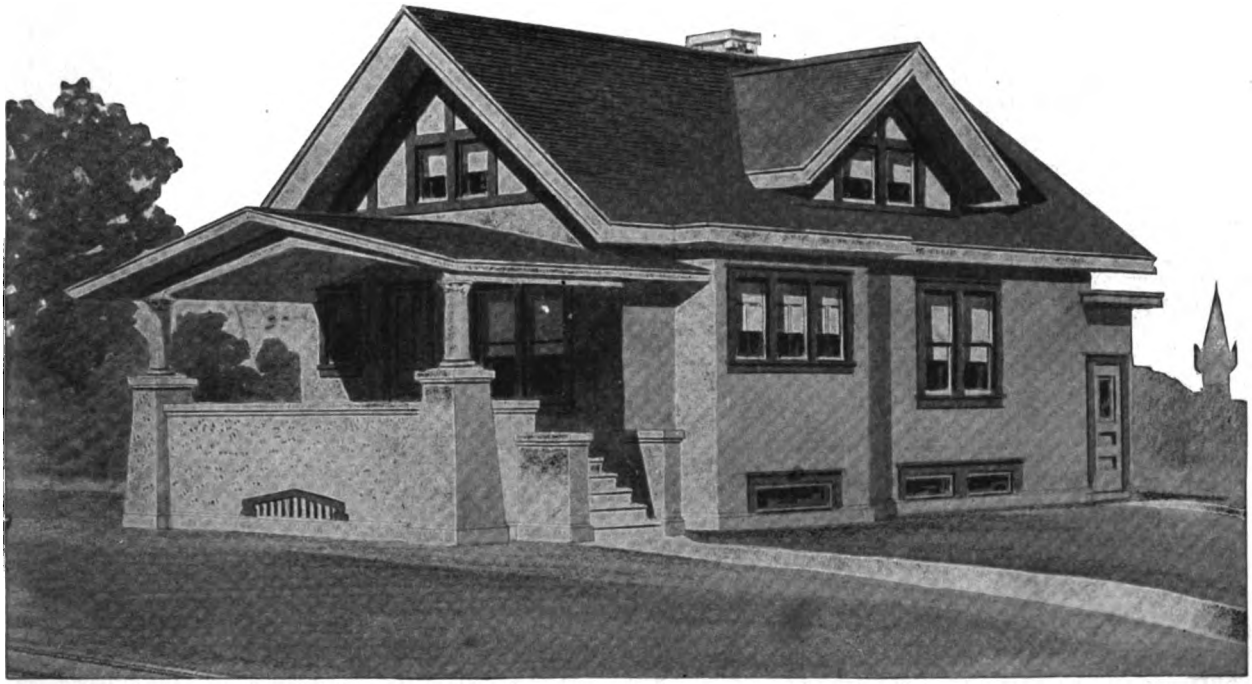
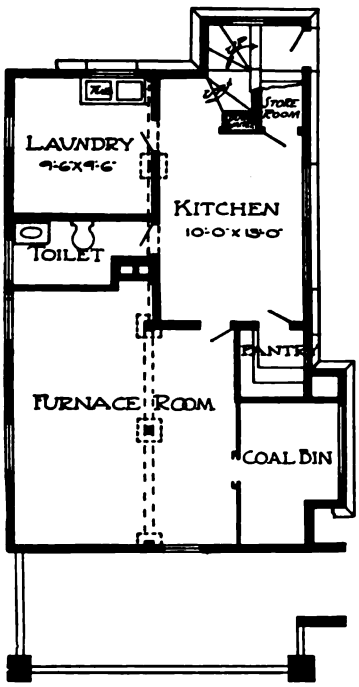
Digitized by Google



Design No. 8196

Size: Width, 23 feet 6 inches; Length, 37 feet



First Floor Plan

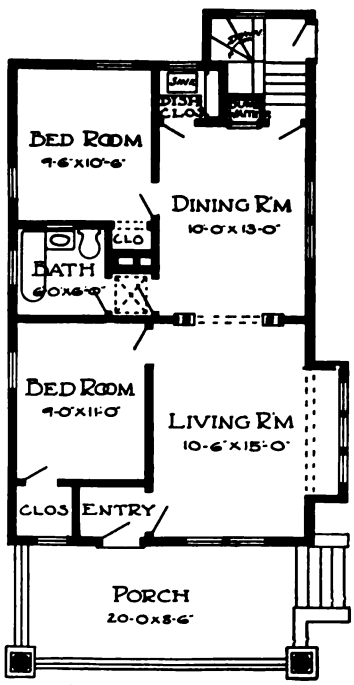
Blue prints consist of basement plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

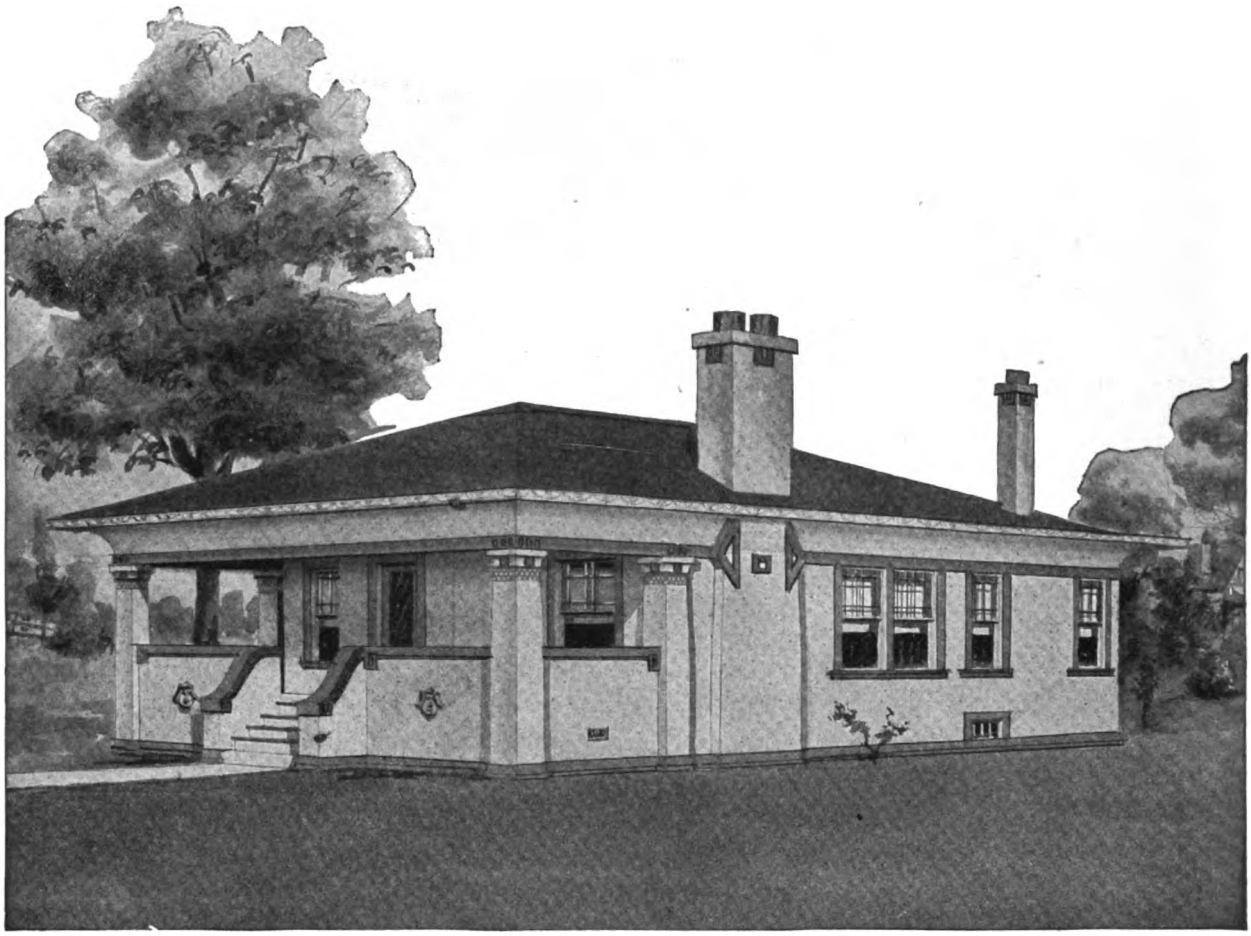
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



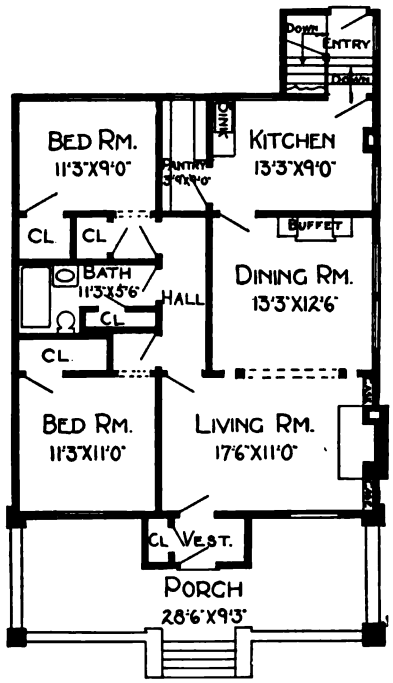
Second Floor Plan

Digitized by Google



Design No. 8301

Size: Width, 30 feet; Length, 34 feet 6 inches



Floor Plan

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

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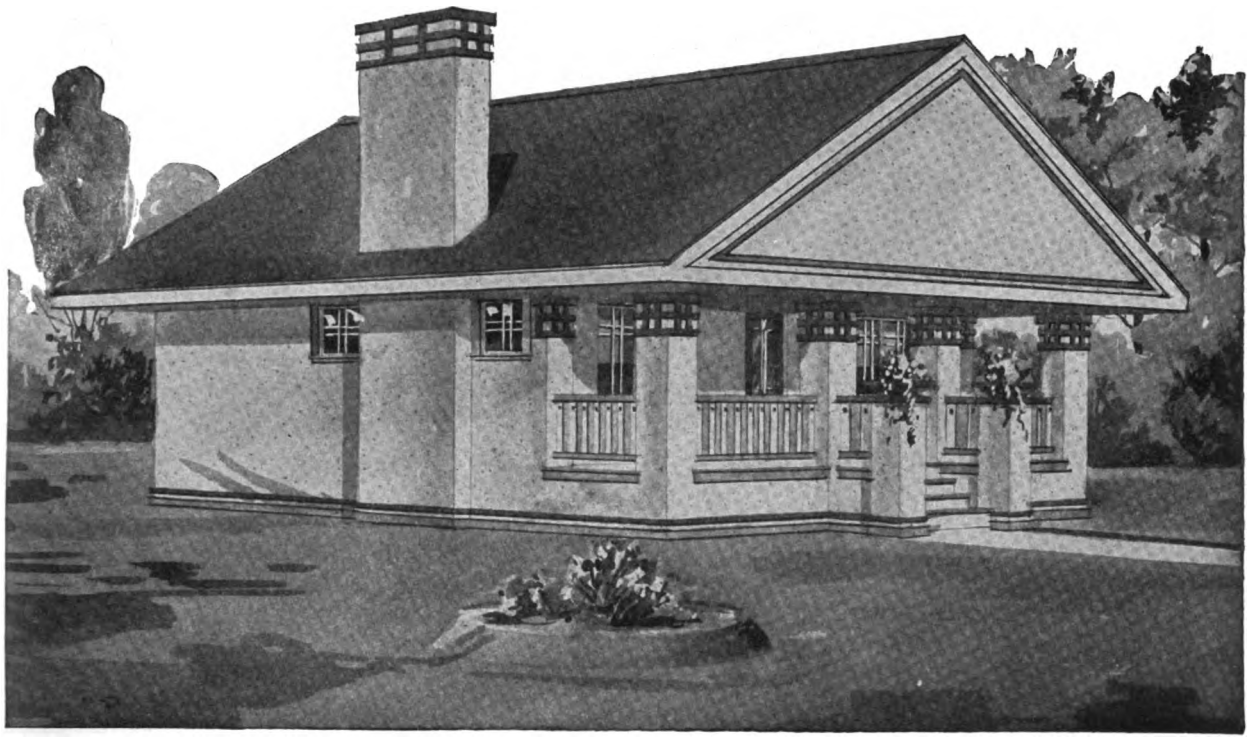
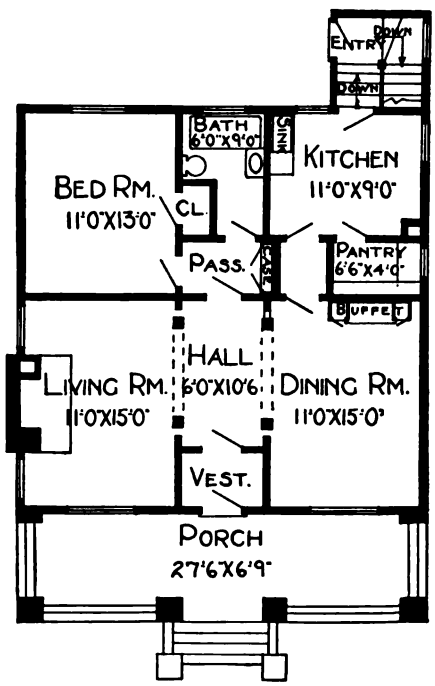
Digitized by Google



Design No. 8308

Size: Width, 30 feet; Length, 29 feet 6 inches

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

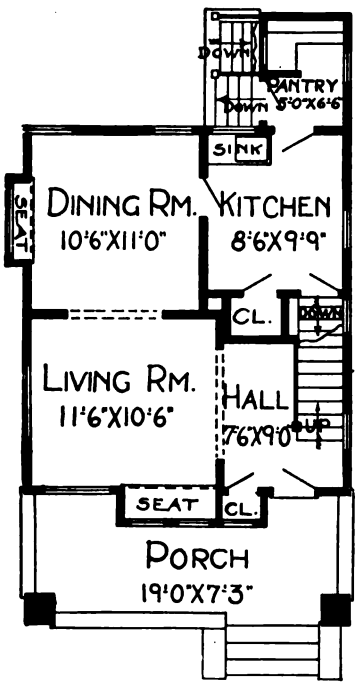
ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google

Design No. 8220

Size: Width, 20 feet 6 inches; Length, 30 feet



First Floor Plan

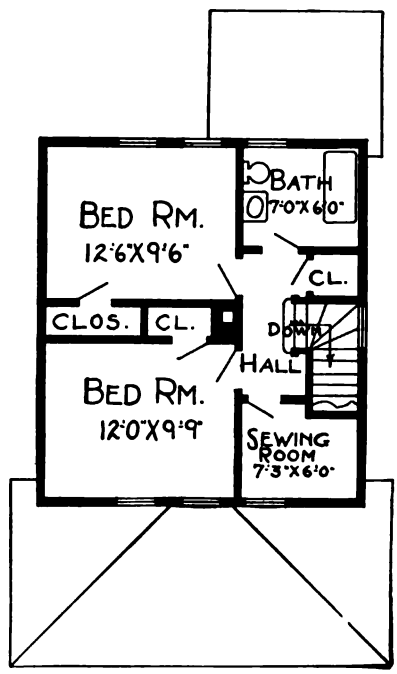
Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

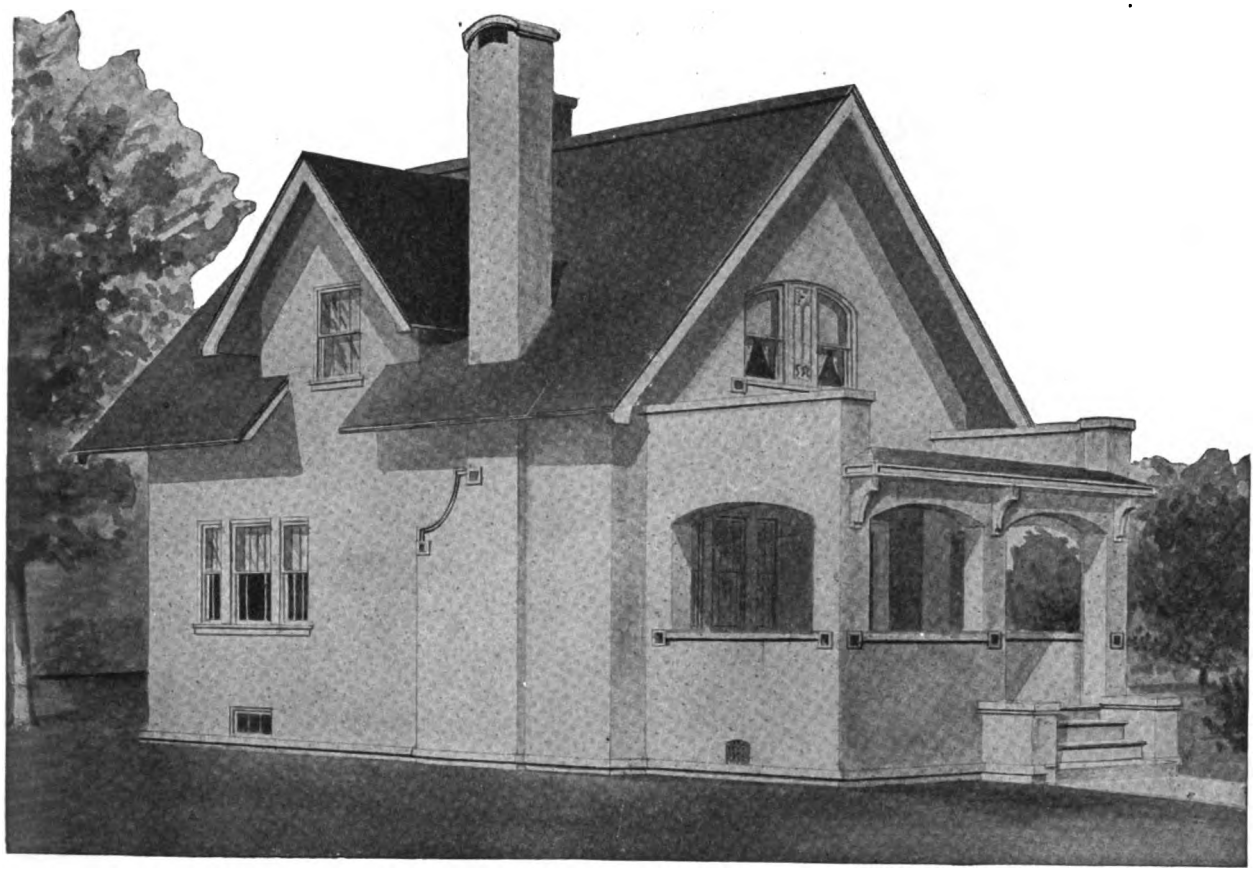
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



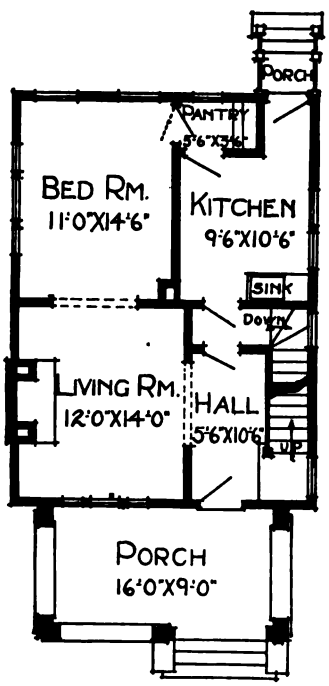
Second Floor Plan

Digitized by Google



Design No. 8268

Size: Width, 22 feet 6 inches; Length, 30 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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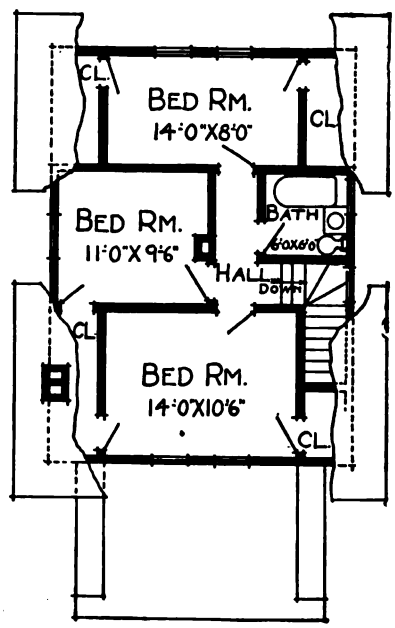
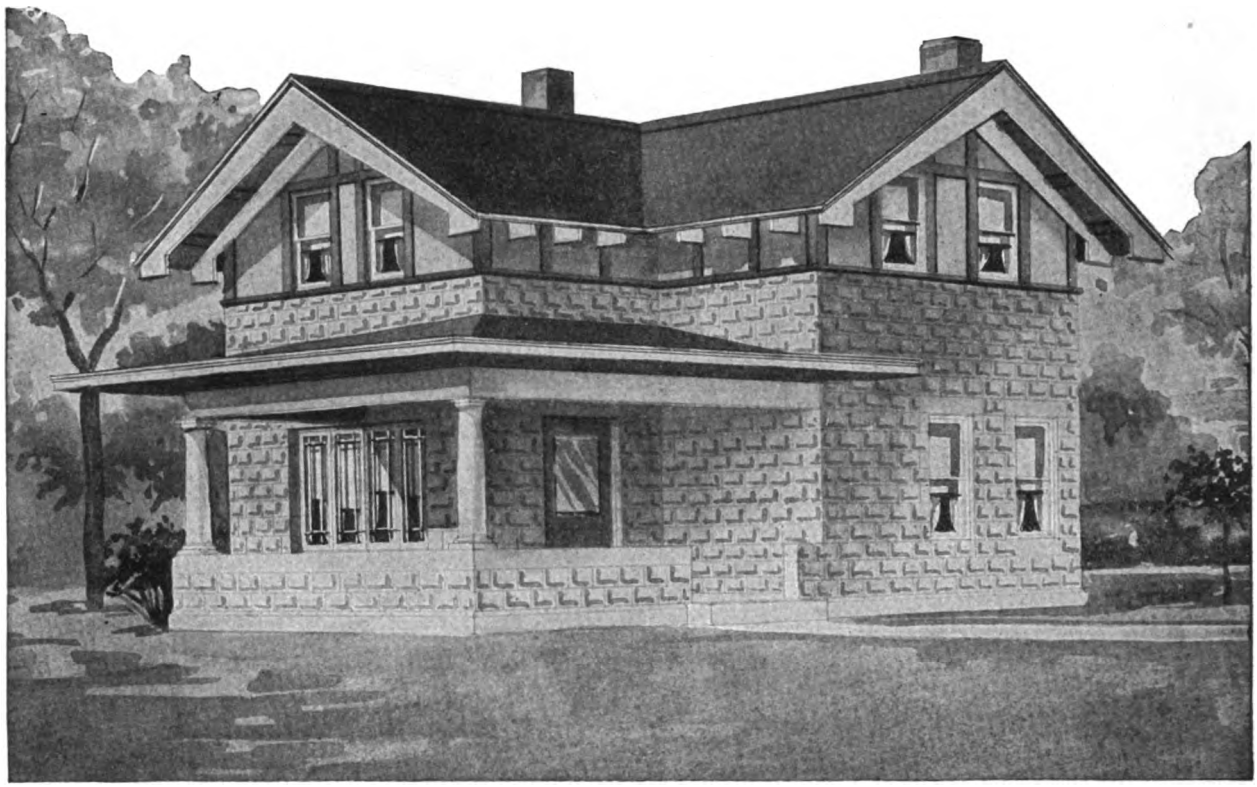


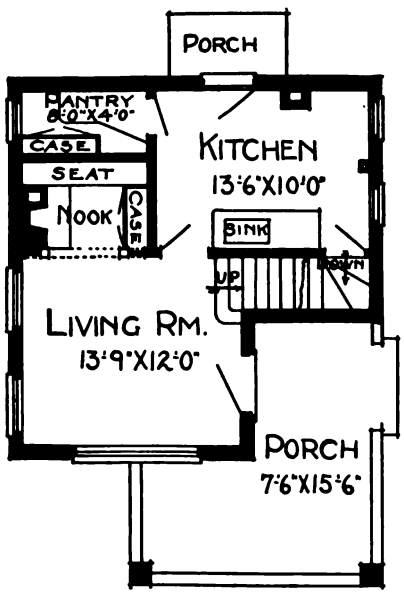
Second Floor Plan

Digitized by Google



Design No. 8240

Size: Width, 23 feet 4 inches; Length, 24 feet



First Floor Plan

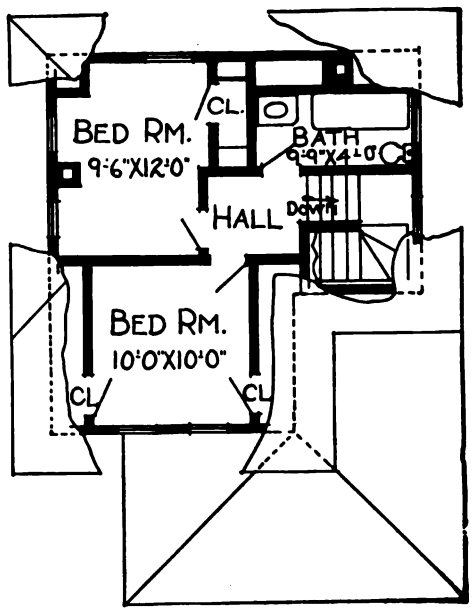
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

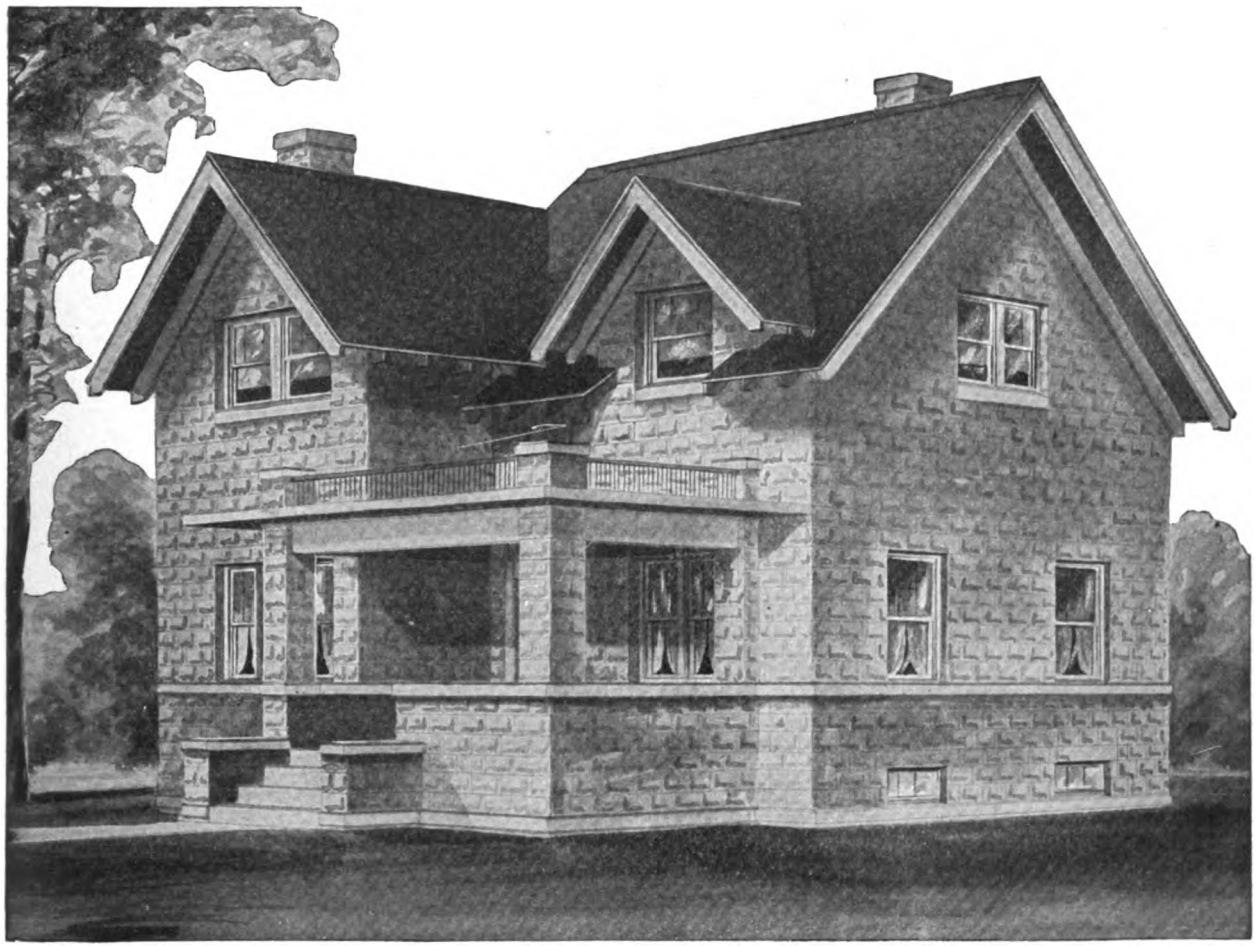
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



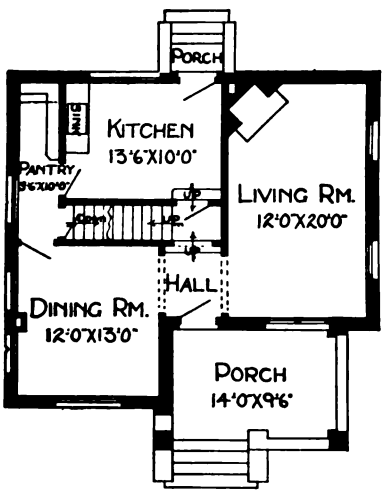
Second Floor Plan

Digitized by Google



Design No. 8242

Size: Width, 31 feet 4 inches; Length, 28 feet 8 inches



First Floor Plan

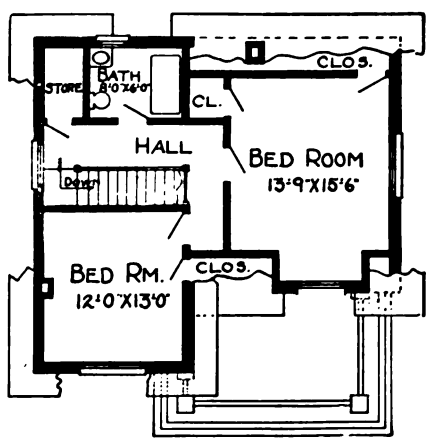
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear and two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

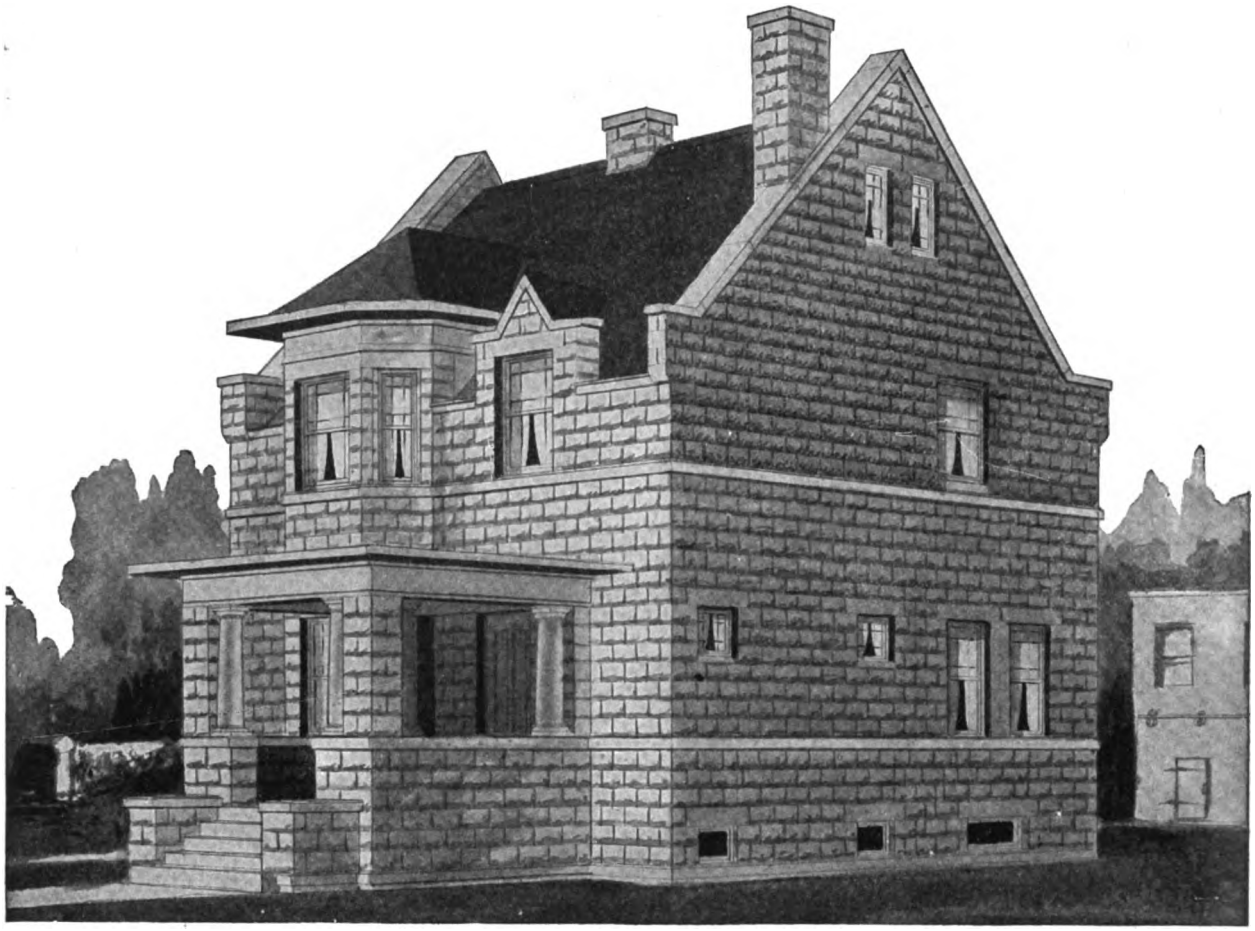
ONLY FIFTEEN DOLLARS

We mail Plans and Specifications the same day order is received.



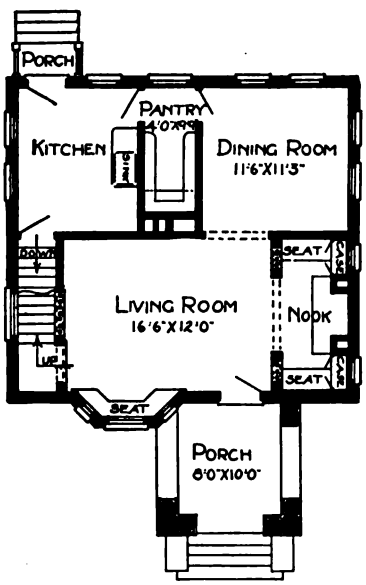
Second Floor Plan

Digitized by Google



Design No. 8205

Size: Width, 25 feet 4 inches; Length, 27 feet 4 inches



First Floor Plan

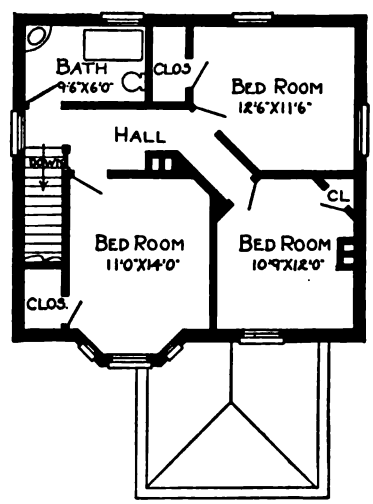
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

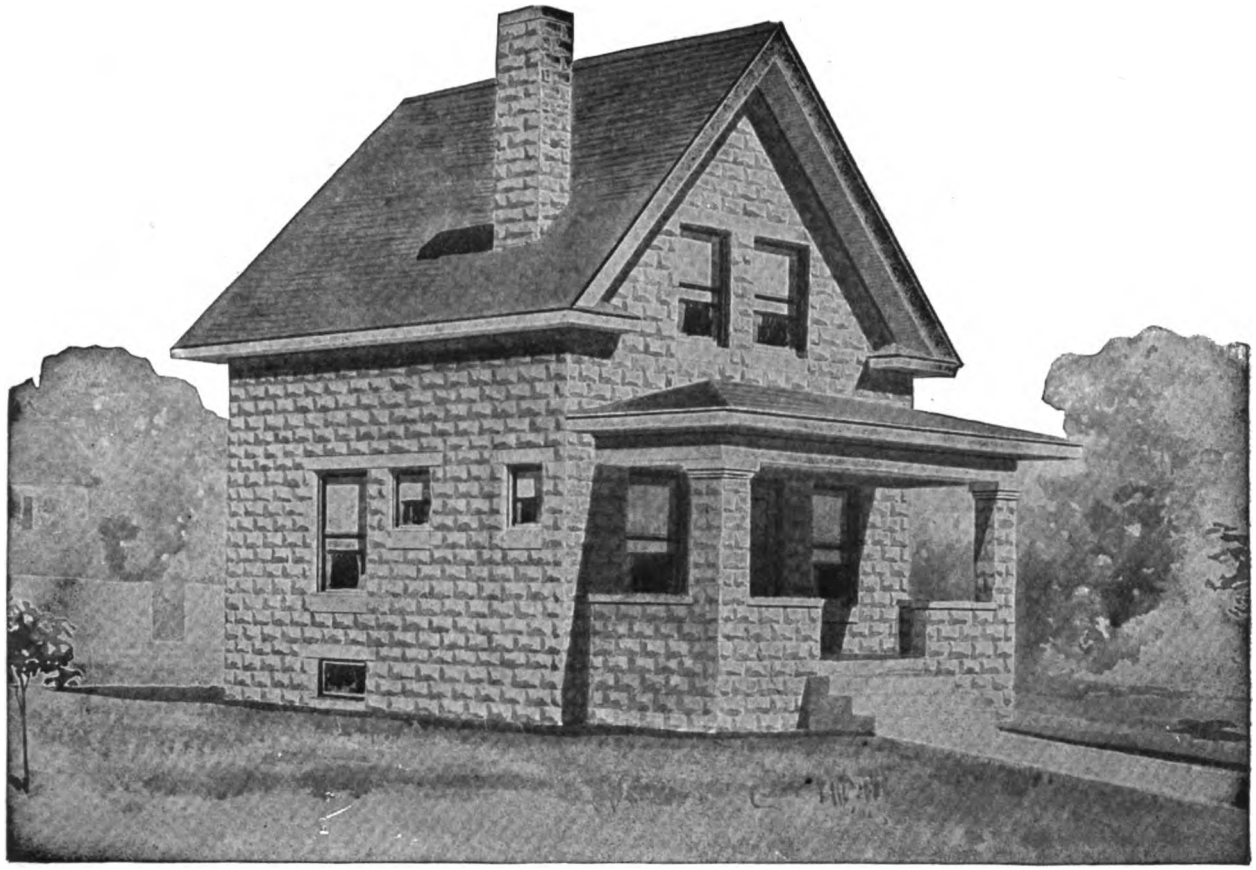
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



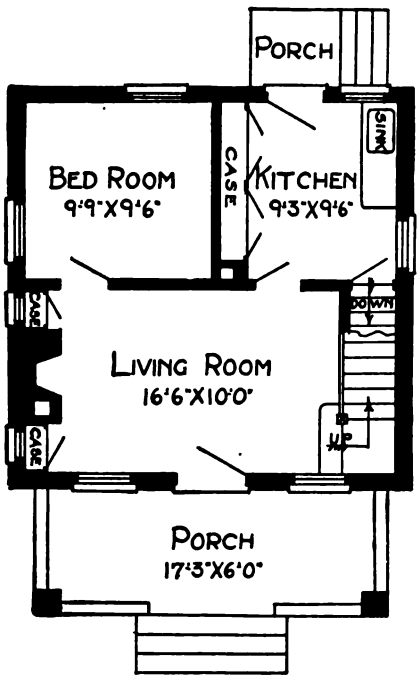
Second Floor Plan

Digitized by Google



Design No. 8214

Size: Width, 21 feet 4 inches; Length, 21 feet 4 inches



First Floor Plan

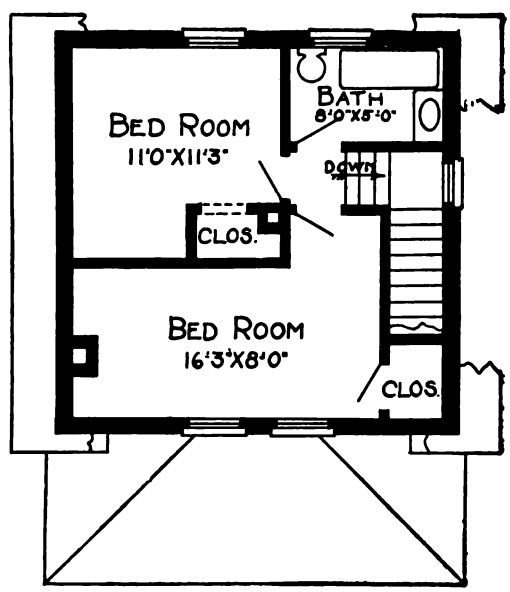
Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

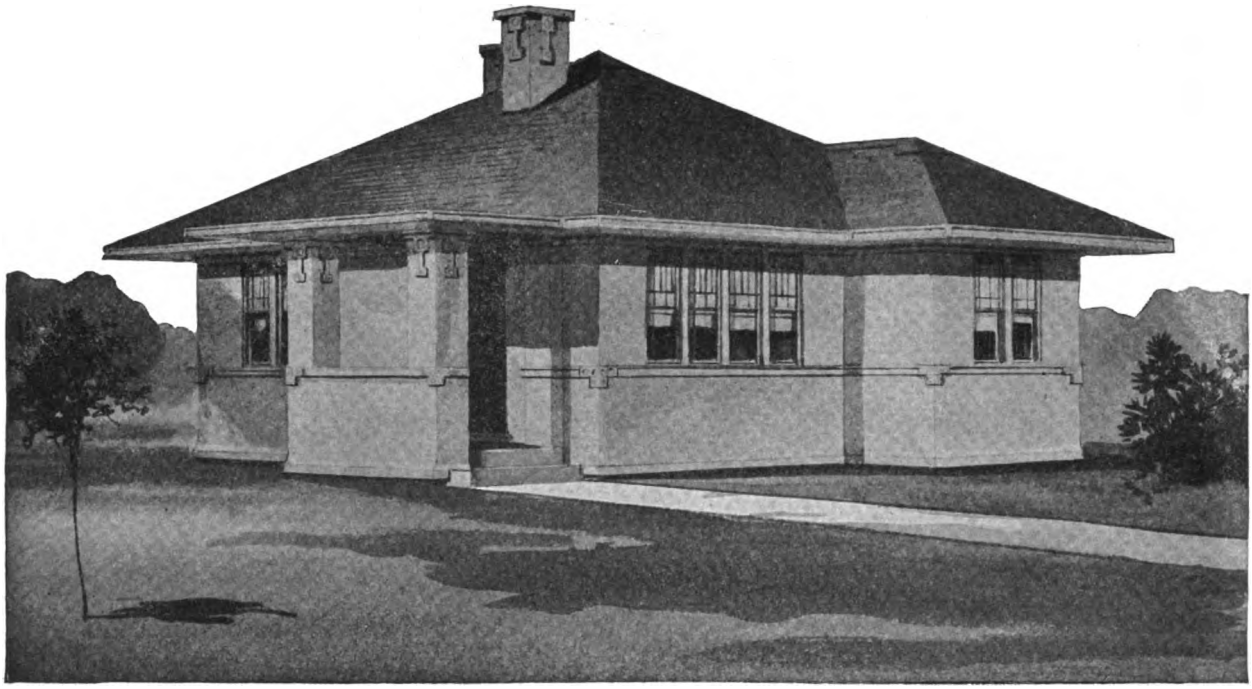
ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.



Second Floor Plan

Digitized by Google



Design No. 8294

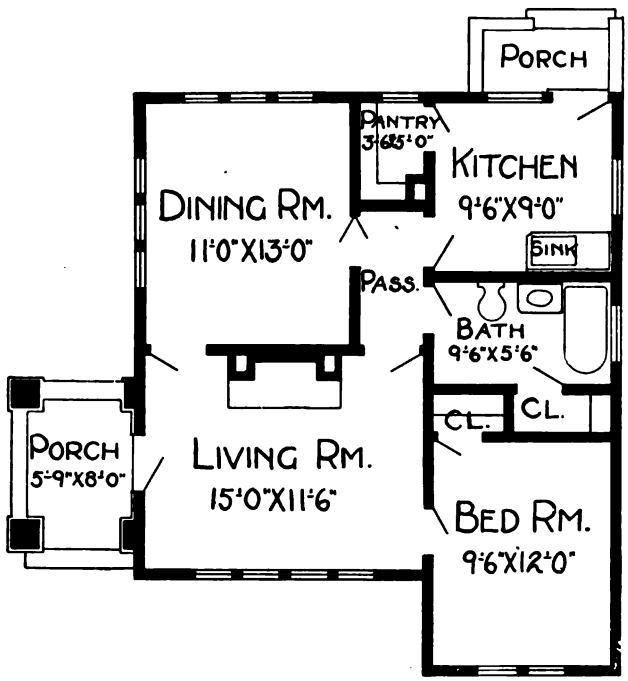
Size: Width, 26 feet; Length, 31 feet

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

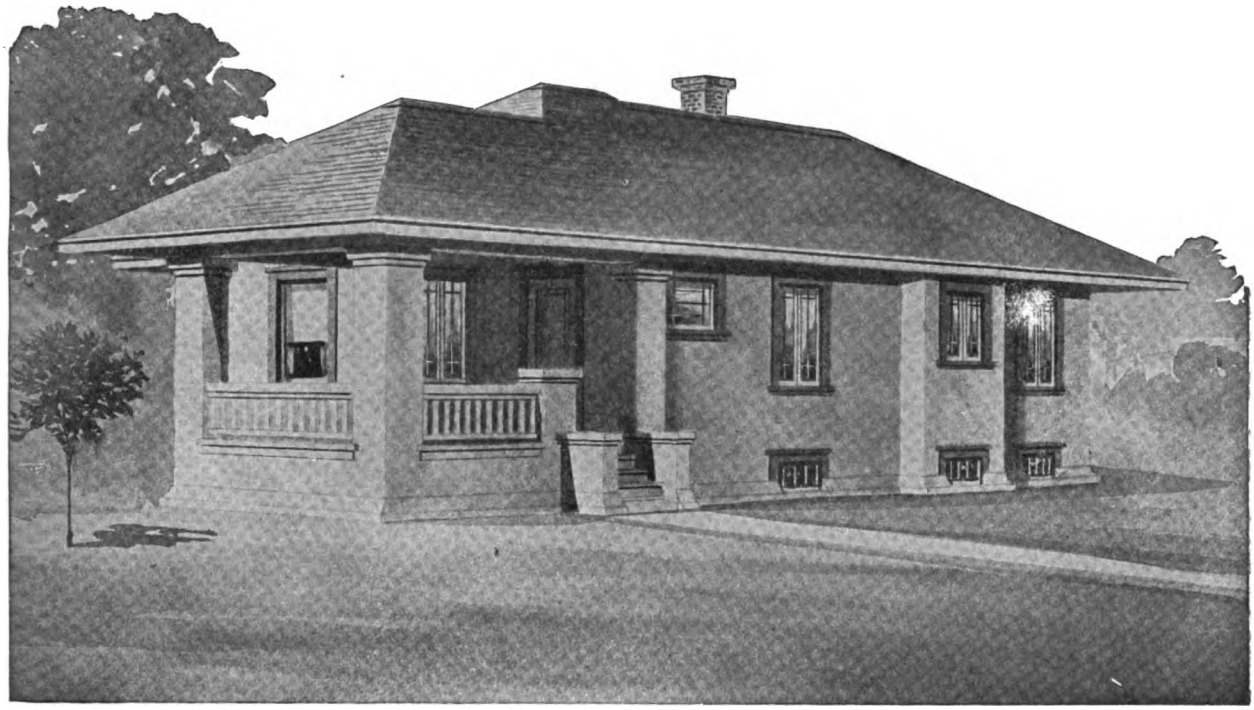
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

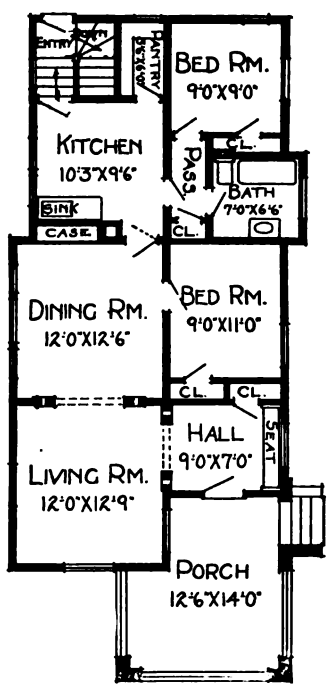
Digitized by Google



Design No. 8243

Size: Width, 24 feet; Length, 44 feet 6 inches

Blue prints consist of basement plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.



Floor Plan

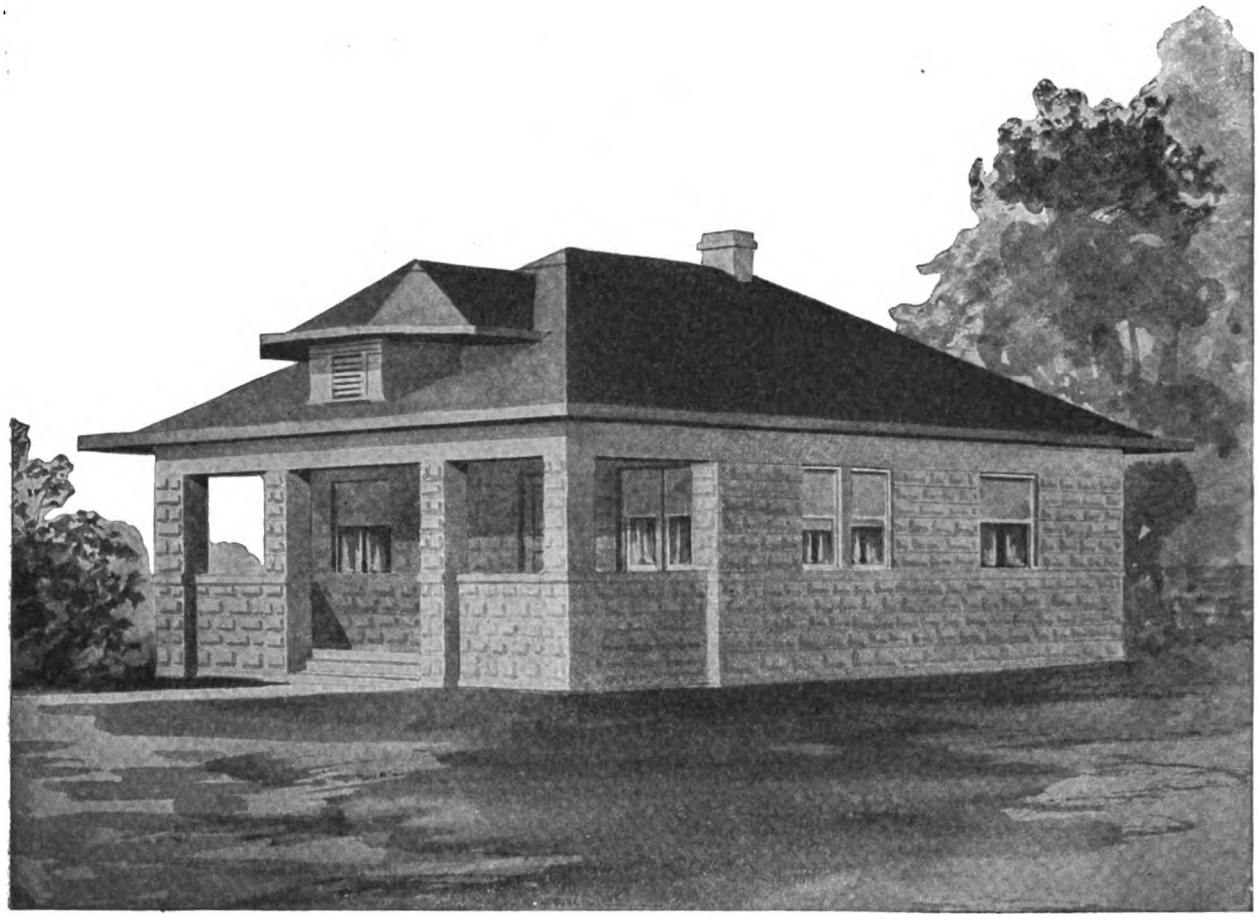
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

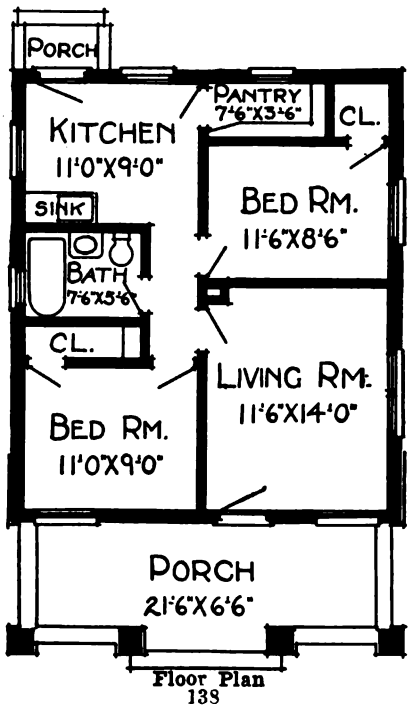
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8265

Size: Width, 24 feet 8 inches; Length, 28 feet 4 inches



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

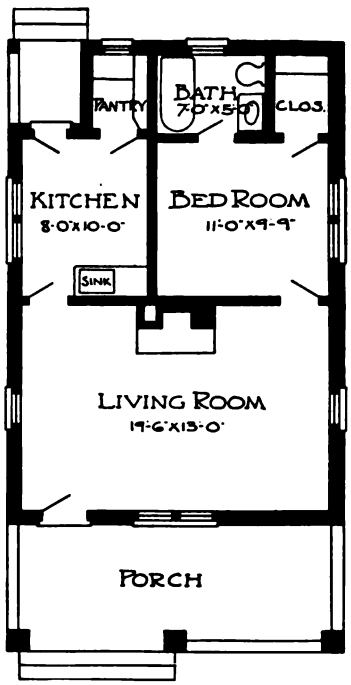
Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

Digitized by Google

Design No. 8194

Size: Width, 21 feet 4 inches; Length, 30 feet 8 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

139

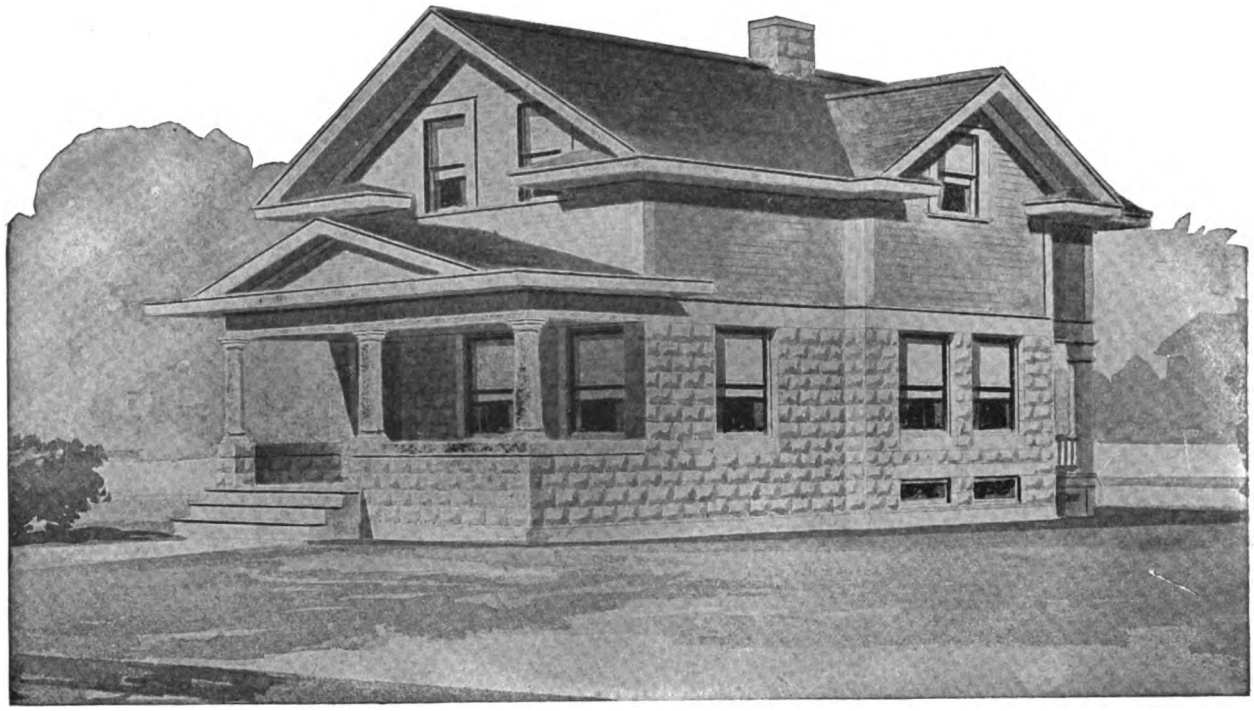
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

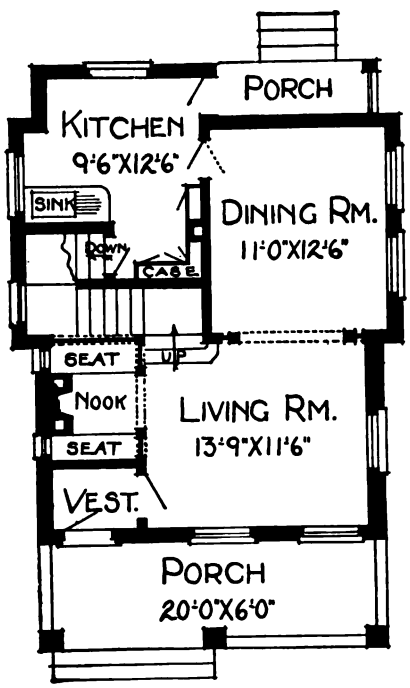
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8237

Size: Width, 24 feet; Length, 29 feet 8 inches



First Floor Plan

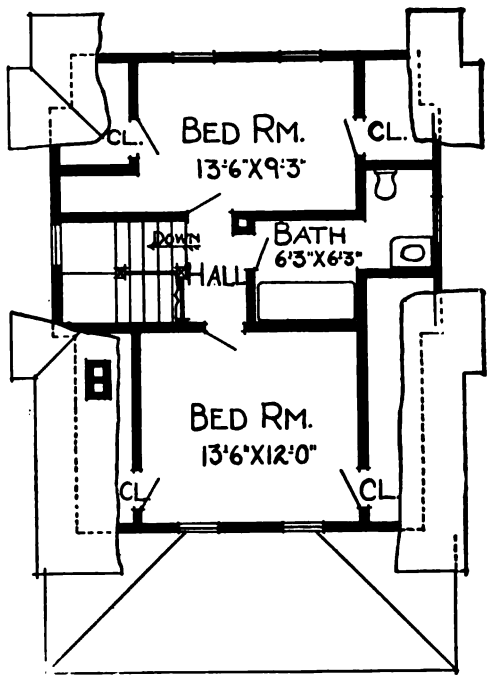
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all neccssary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

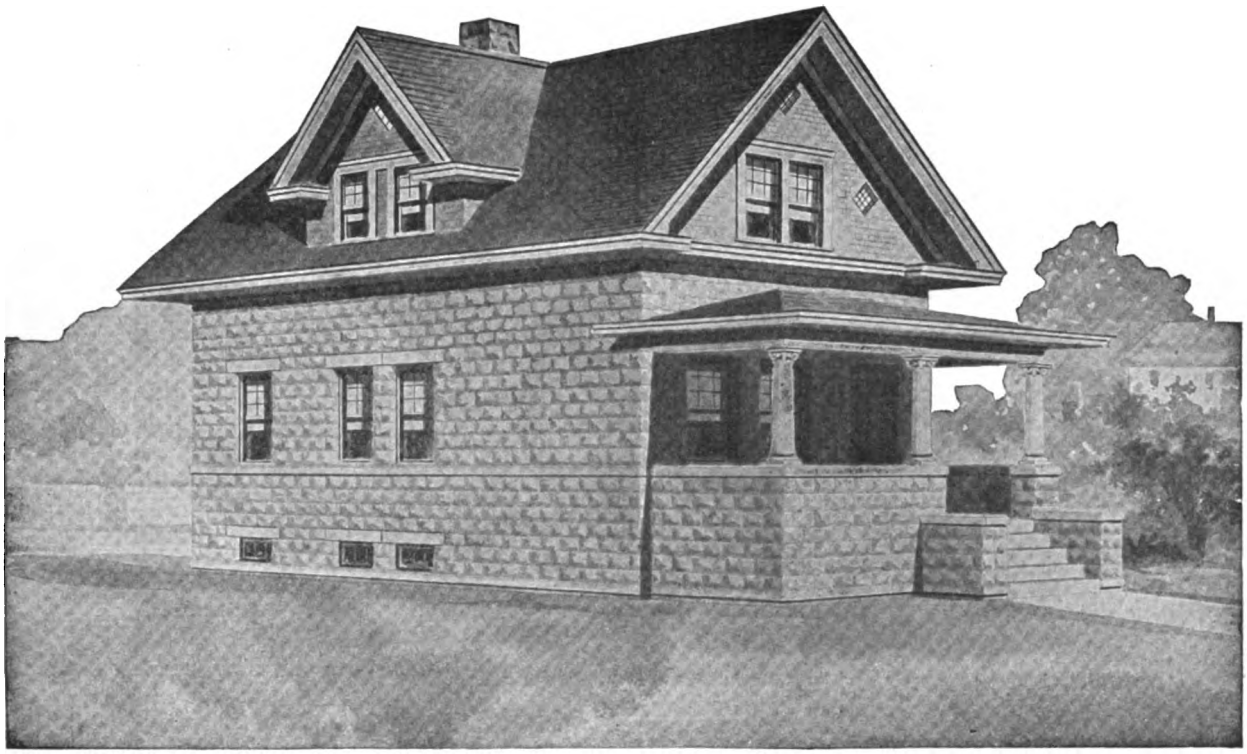
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



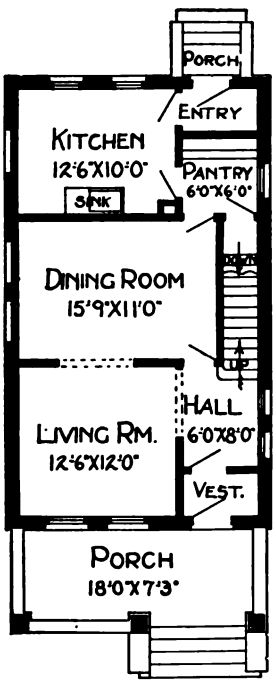
Second Floor Plan

Digitized by Google



Design No. 8235

Size: Width, 20 feet 8 inches; Length, 36 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

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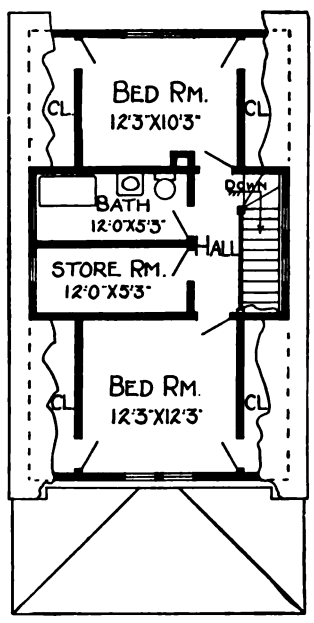
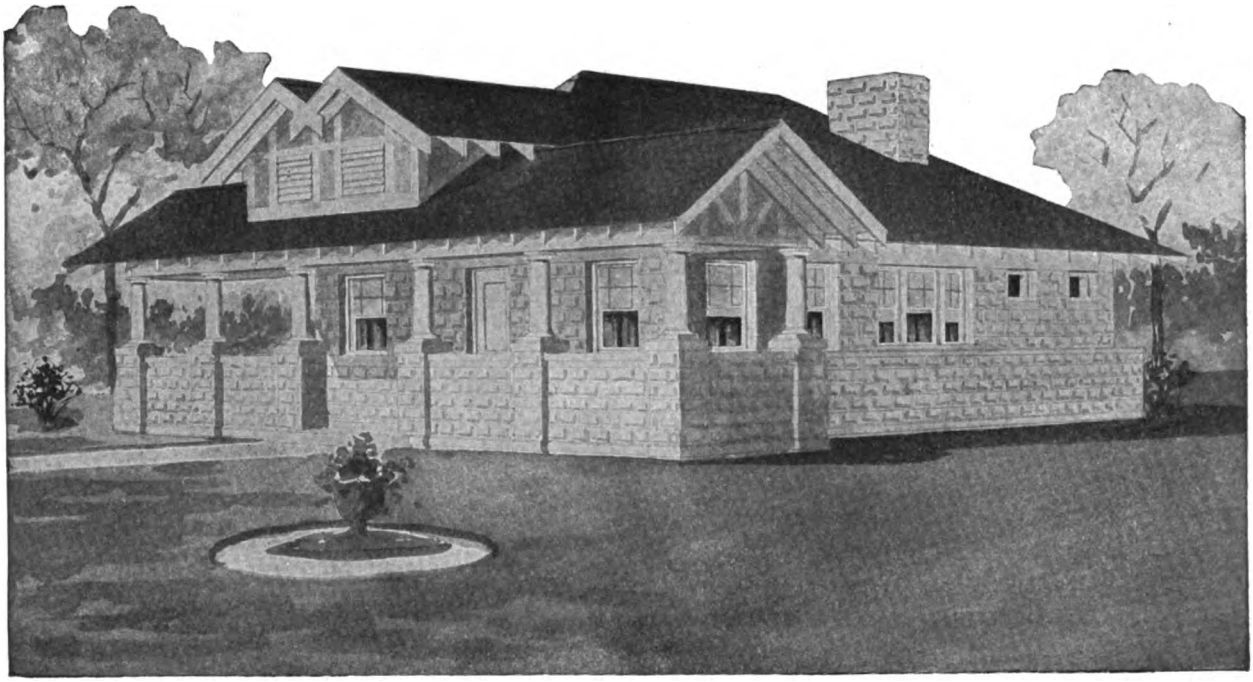


Second Floor Plan

Digitized by Google



Design No. 8255

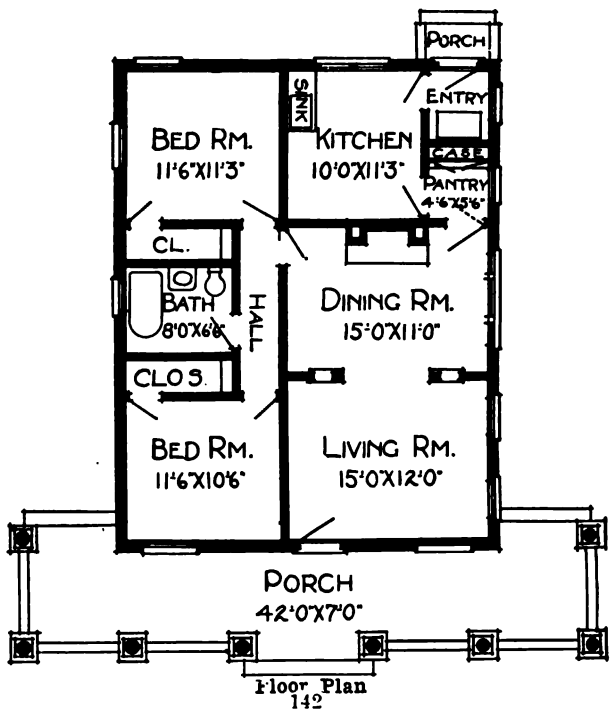
Size: Width, 28 feet 8 inches; Length, 36 feet 8 inches

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

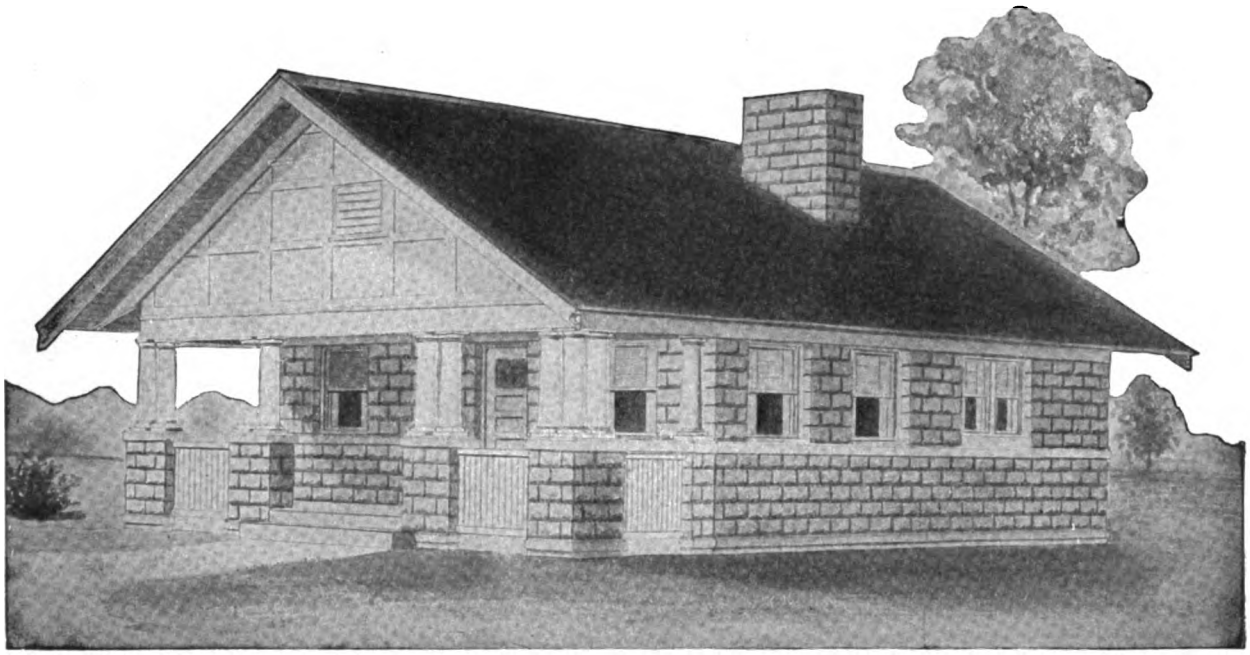
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

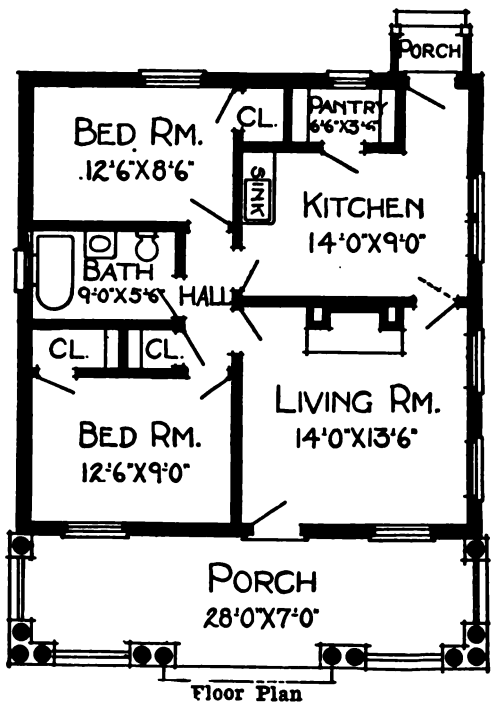
Digitized by Google



Design No. 8252

Size: Width, 28 feet 8 inches; Length, 28 feet 8 inches

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

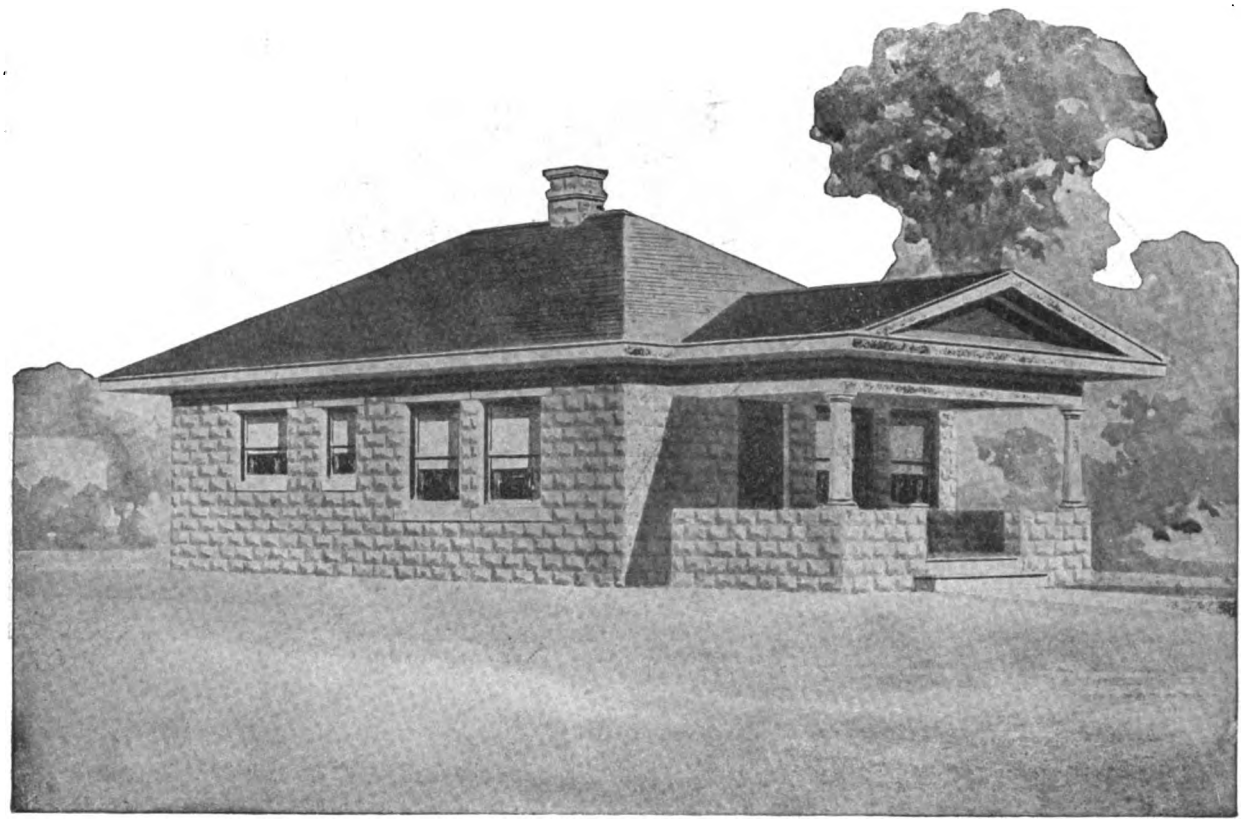
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8229

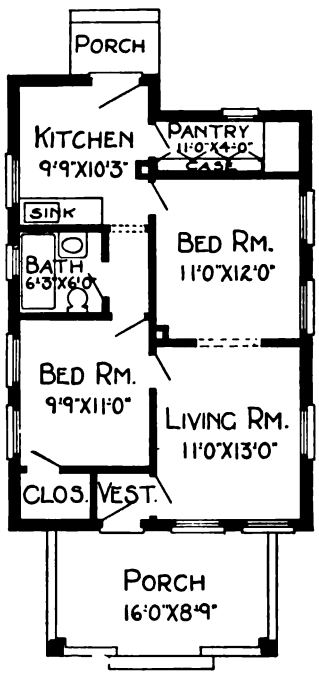
Size: Width, 22 feet 8 inches; Length, 34 feet

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

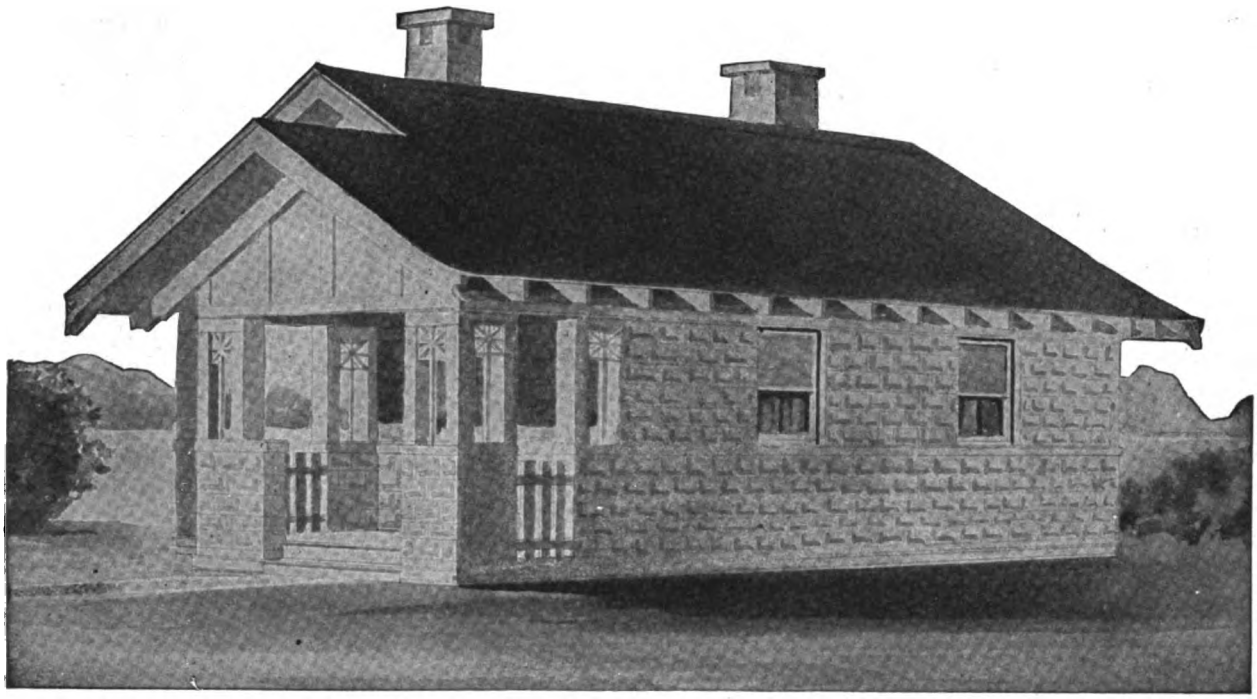
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

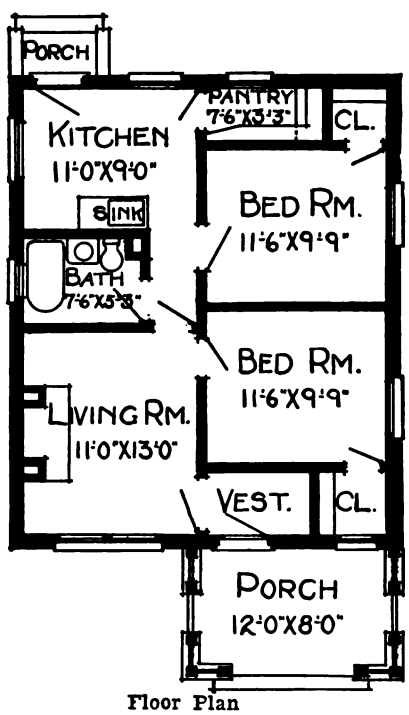
Digitized by Google



Design No. 8262

Size: Width, 24 feet 8 inches; Length, 30 feet

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

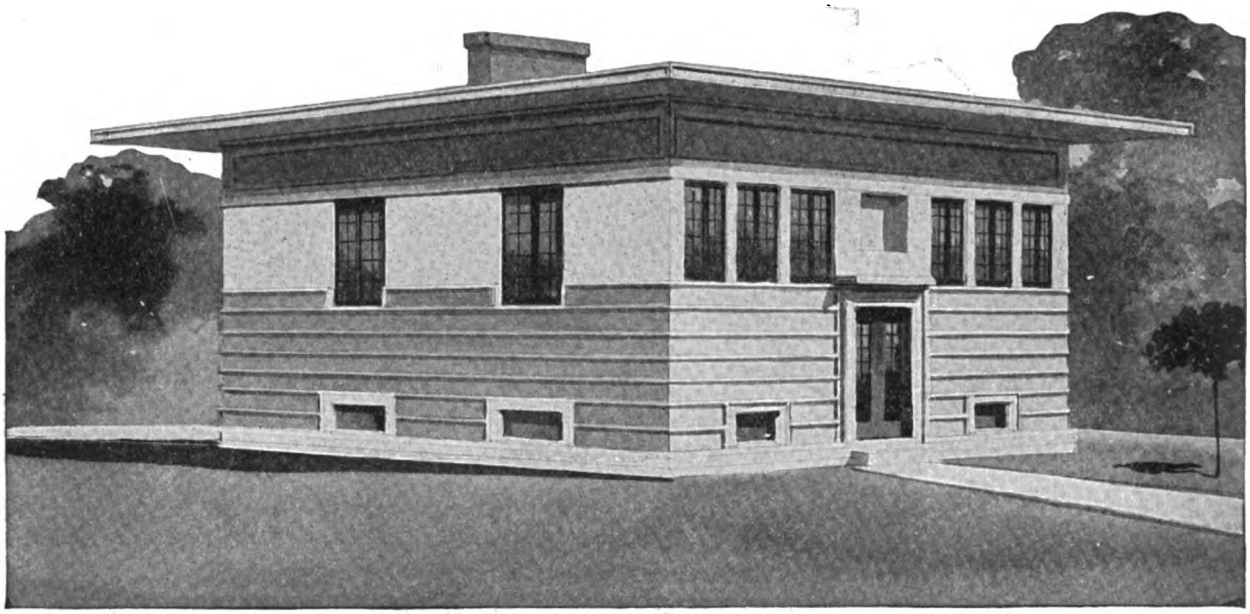
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google



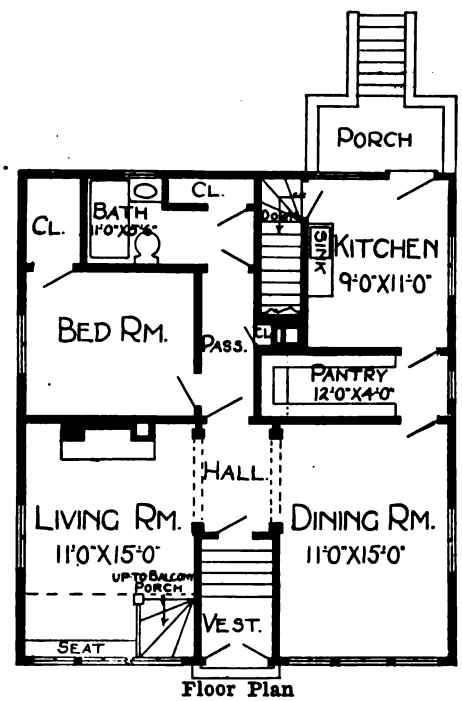
Design No. 8320

Size: Width, 28 feet 6 inches; Length, 32 feet

PRICE
of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

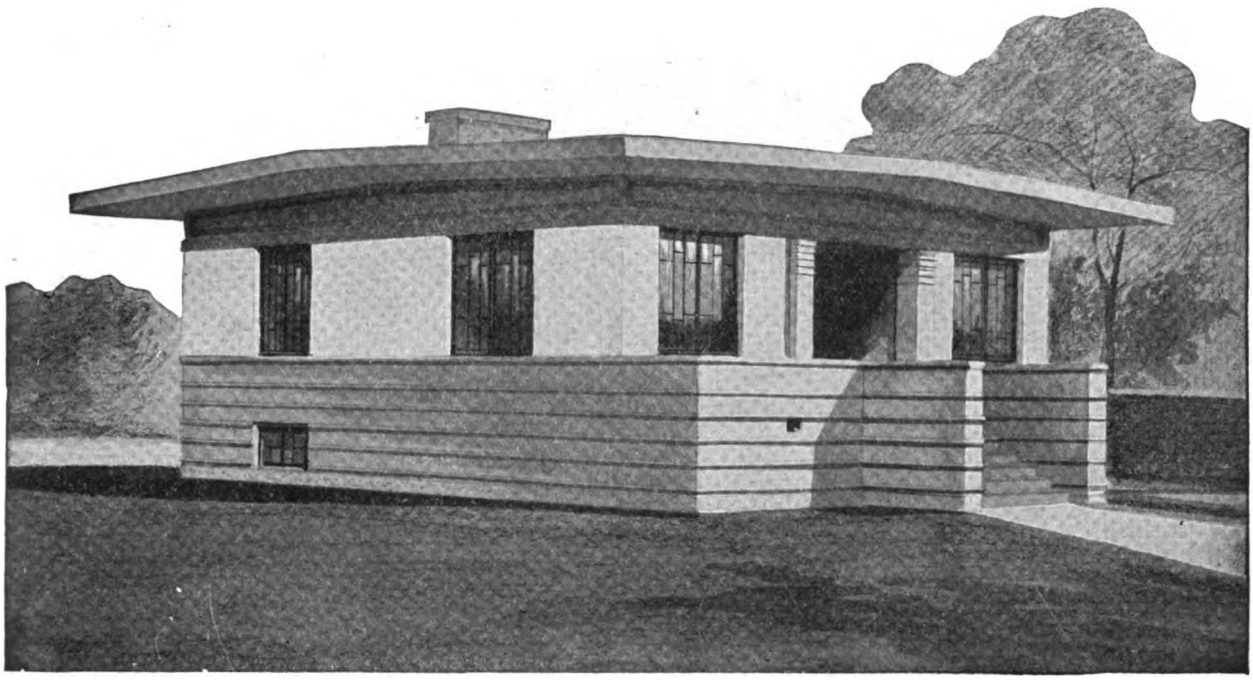
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

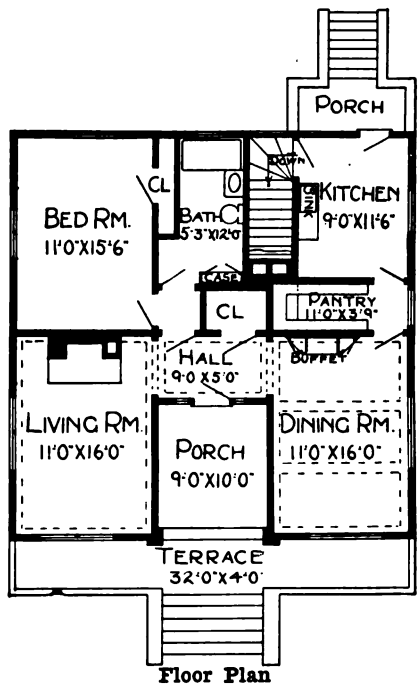
Digitized by Google



Design No. 8321

Size: Width, 32 feet 6 inches; Length, 33 feet

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

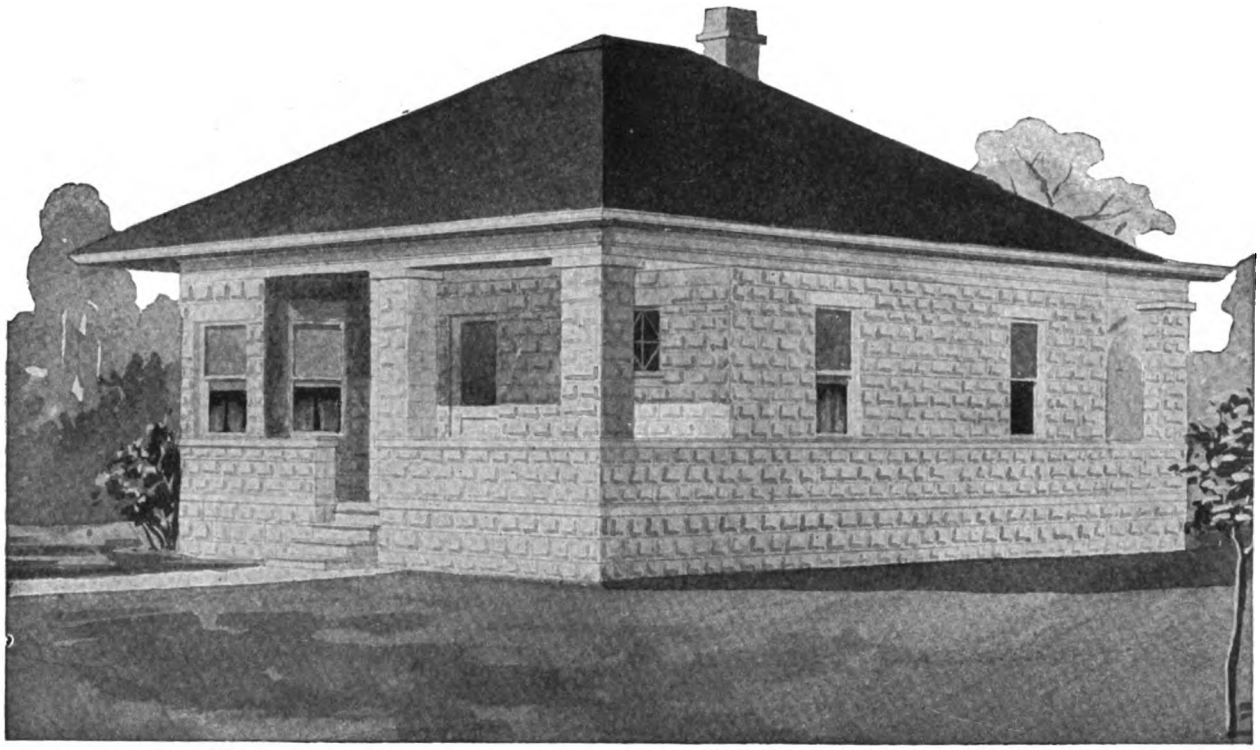
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

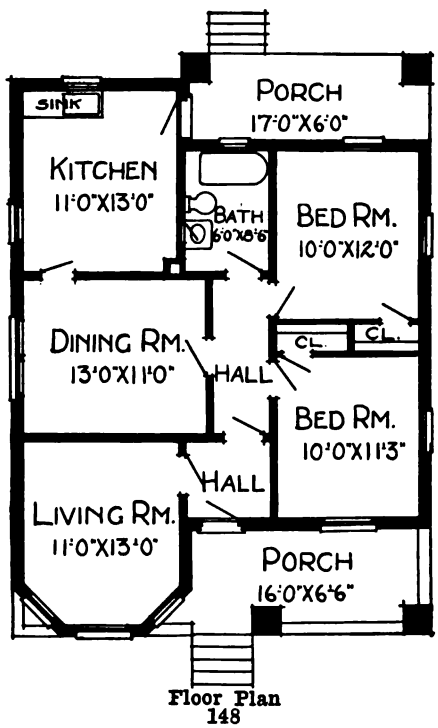
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8256

Size: Width, 29 feet 8 inches; Length, 39 feet 4 inches



Floor Plan
148

PRICE

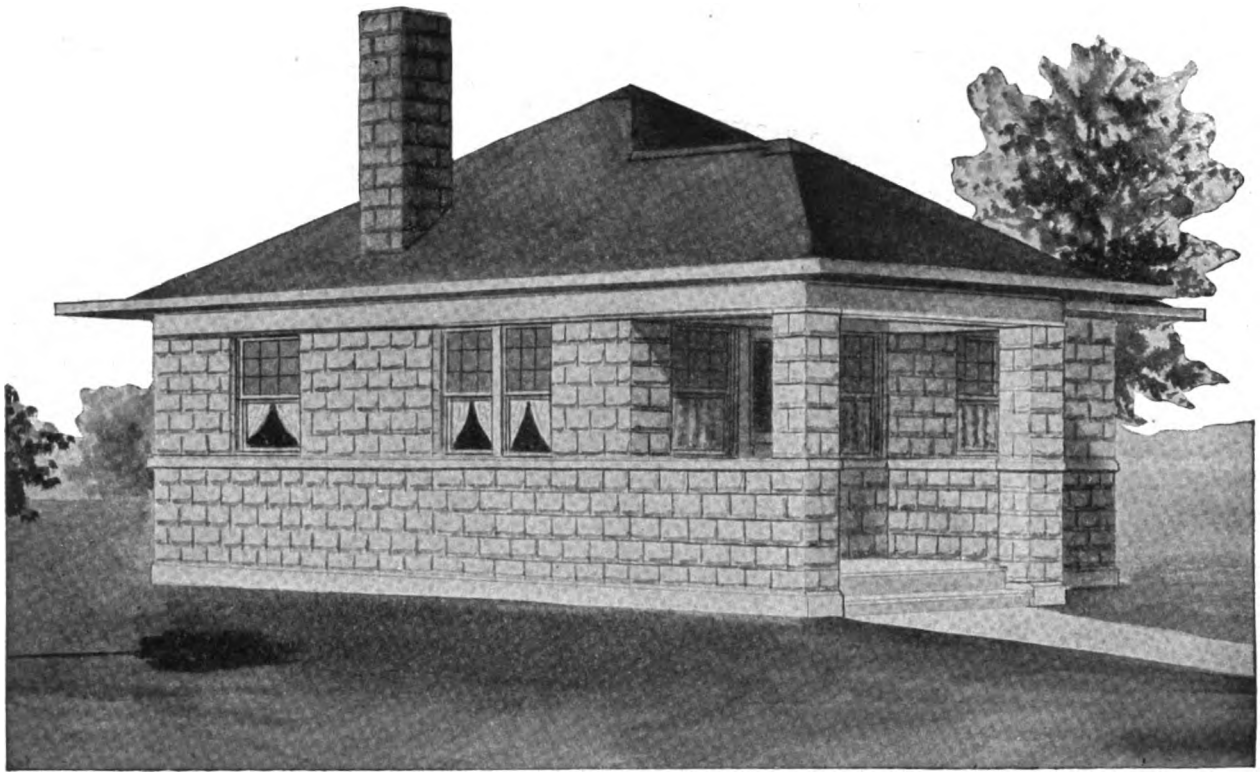
of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

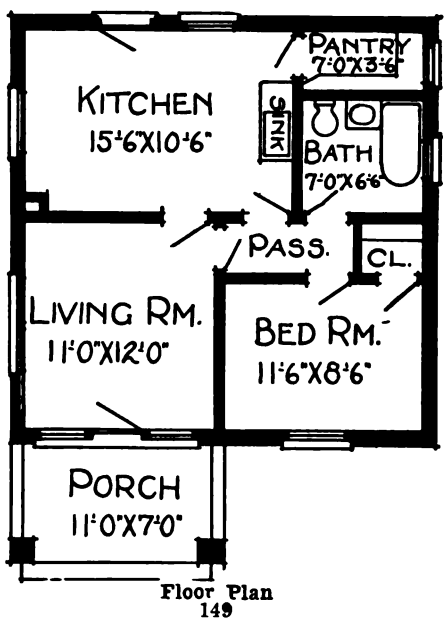
Digitized by Google



Design No. 8257

Size: Width, 24 feet 4 inches; Length, 24 feet 8 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

149

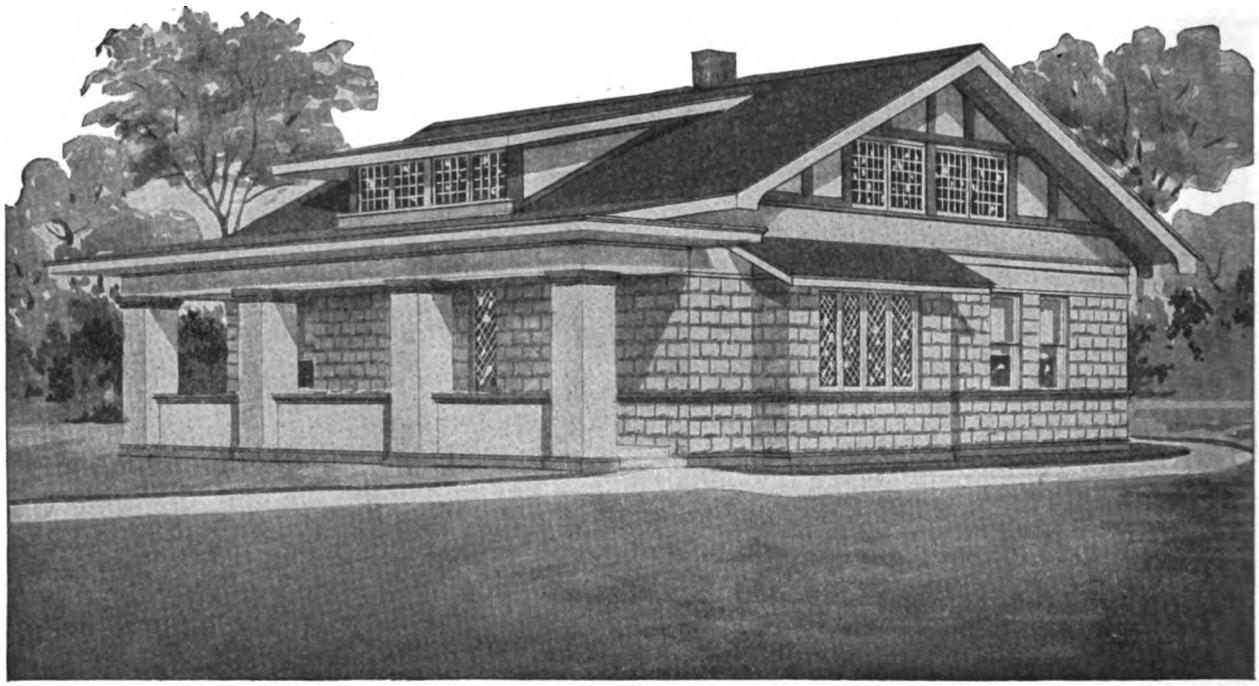
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8295

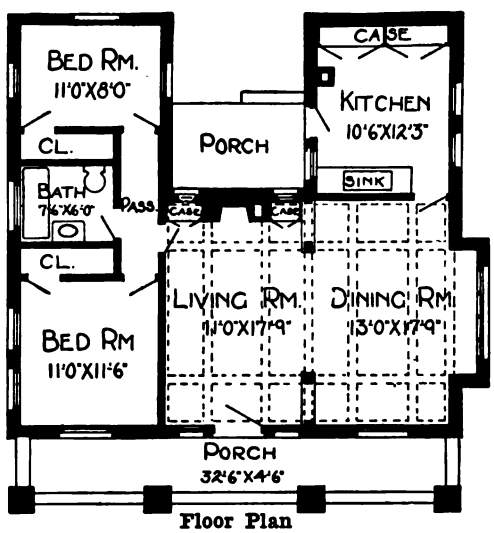
Size: Width, 37 feet 8 inches; Length, 33 feet 4 inches

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

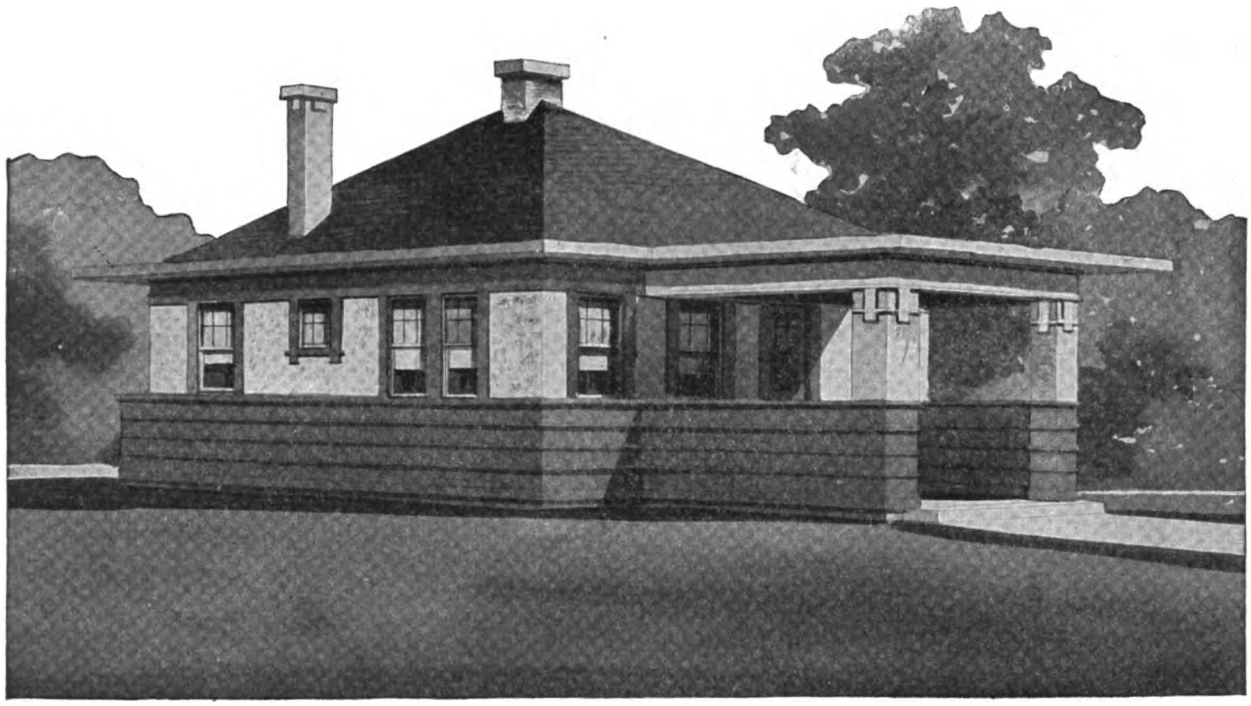
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of foundation plan; floor plan; front, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

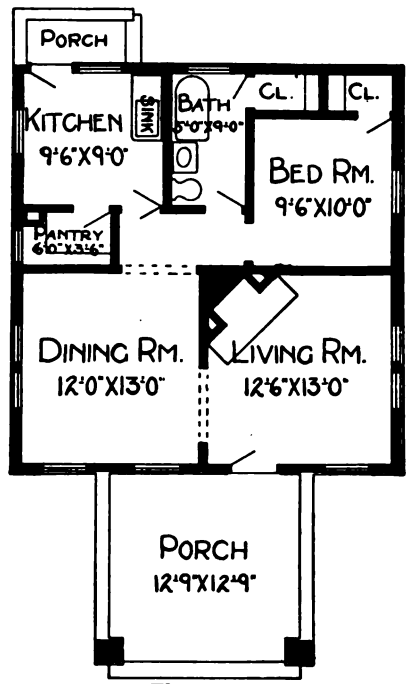
Digitized by Google



Design No. 8304

Size: Width, 26 feet; Length, 27 feet 6 inches

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

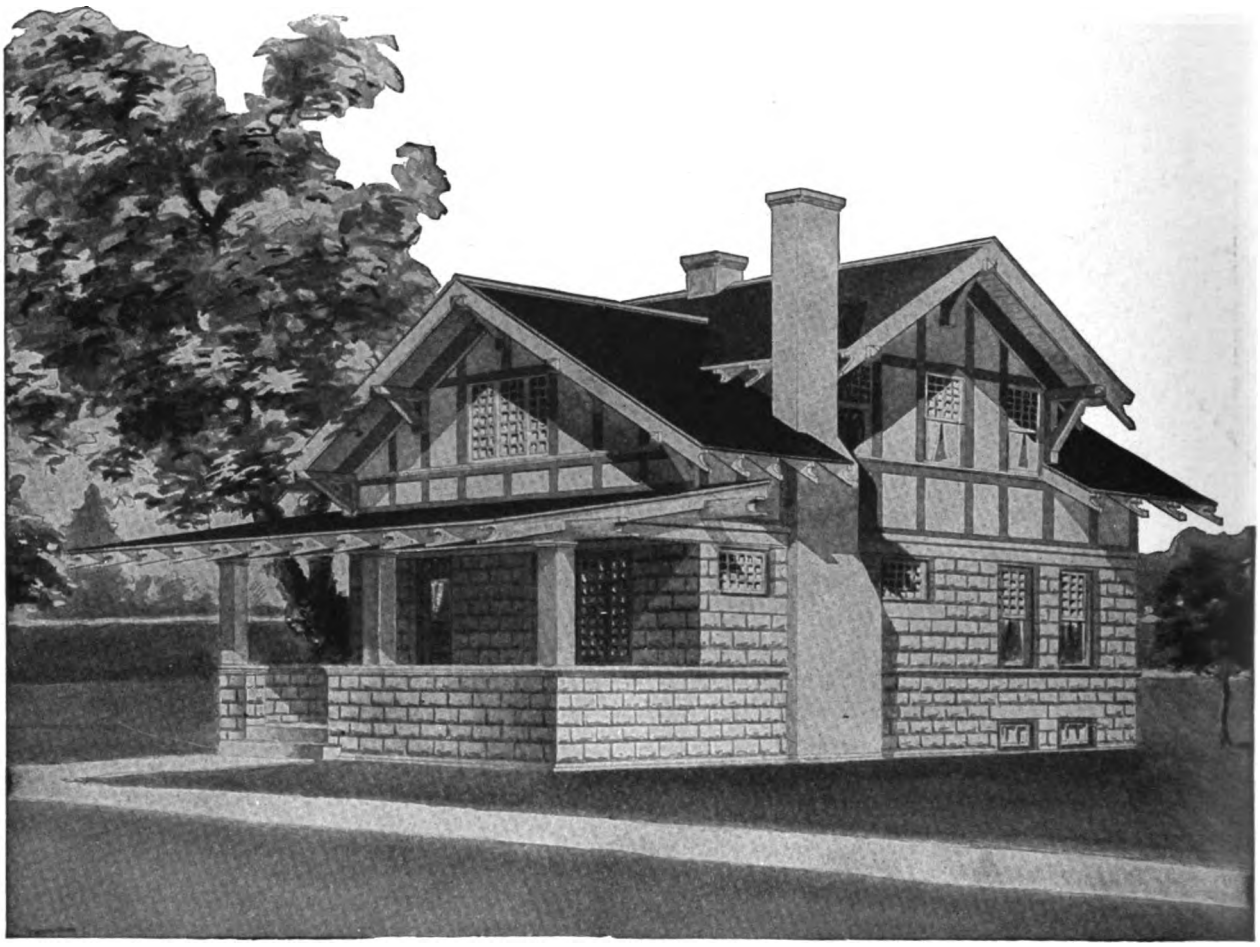
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

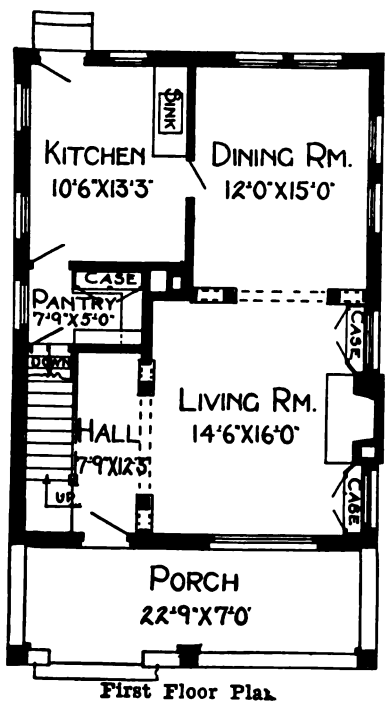
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8306

Size: Width, 24 feet 8 inches; Length, 33 feet 4 inches



First Floor Plan

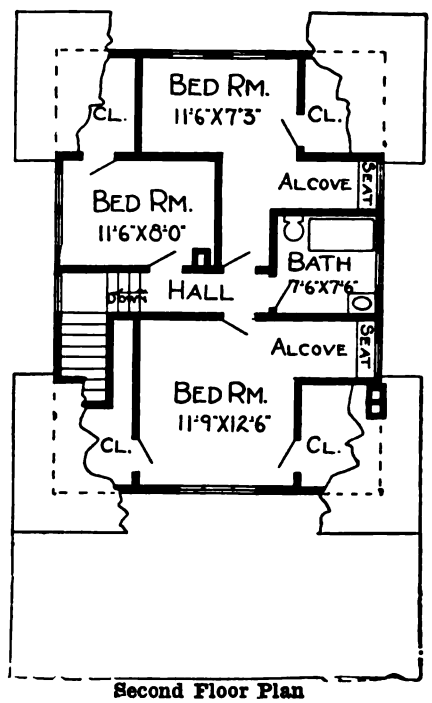
Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear and two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

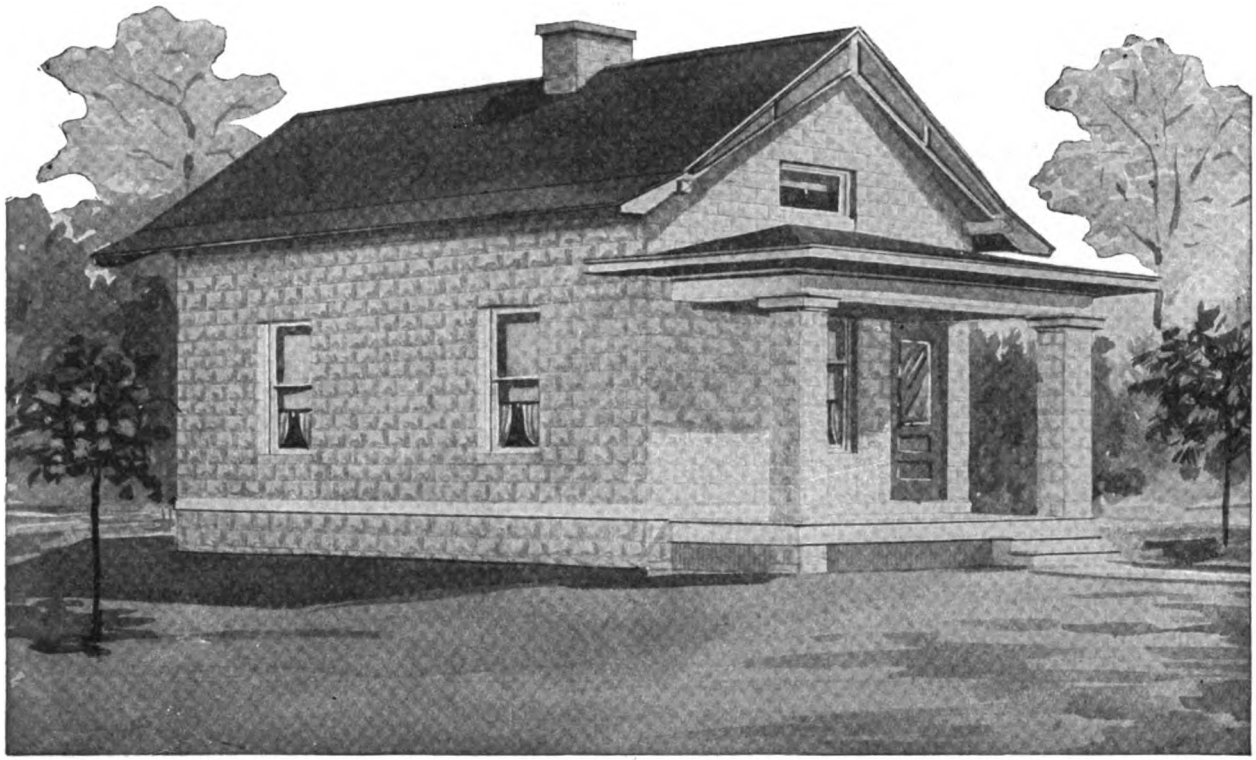
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



Second Floor Plan

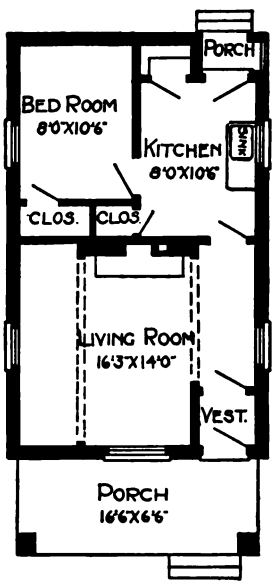
Digitized by Google



Design No. 8190

Size: Width, 17 feet 8 inches; Length, 29 feet 4 inches

Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

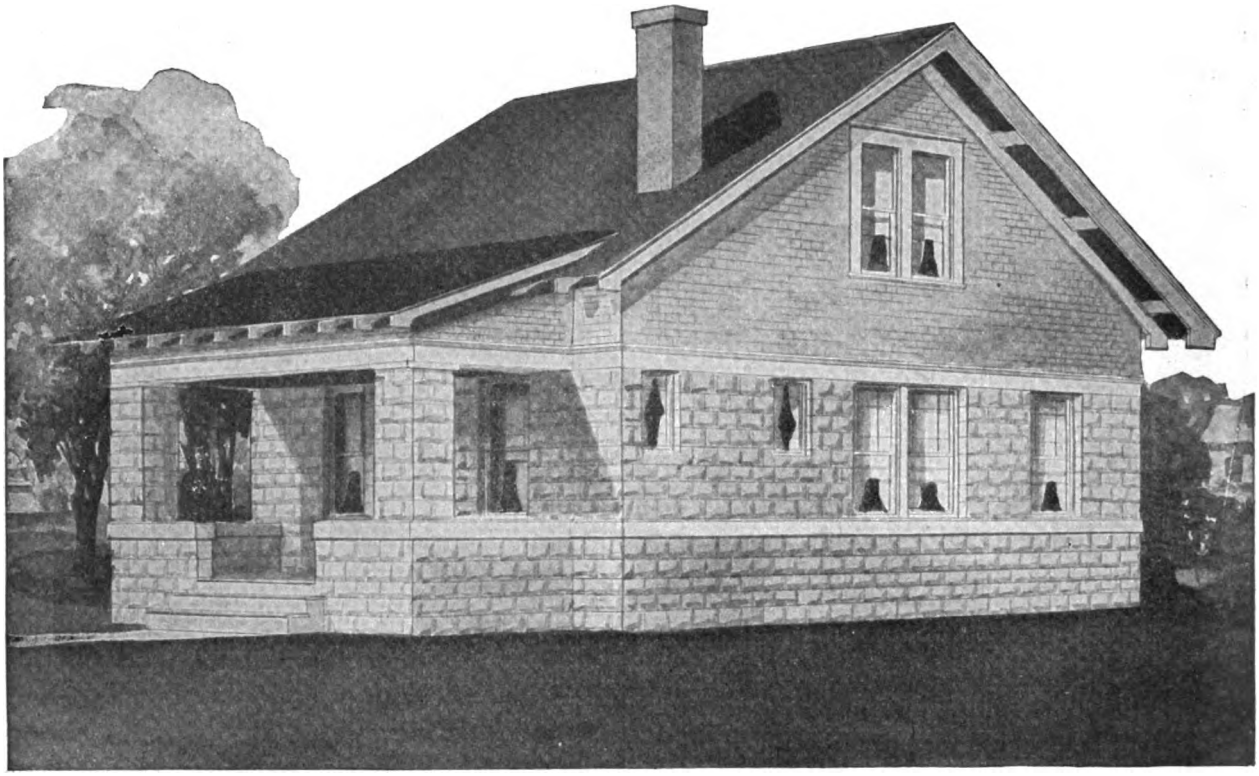
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

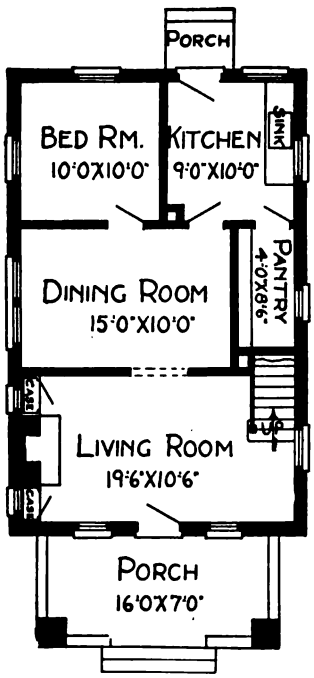
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8221

Size: Width, 21 feet 4 inches; Length, 33 feet 4 inches



First Floor Plan

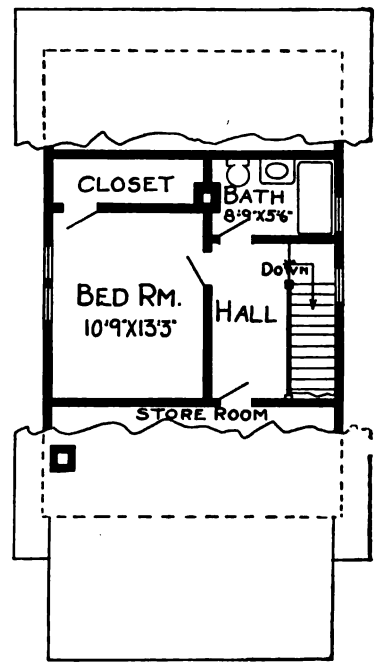
Blue prints consist of foundation plan; first and second floor plans; front, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

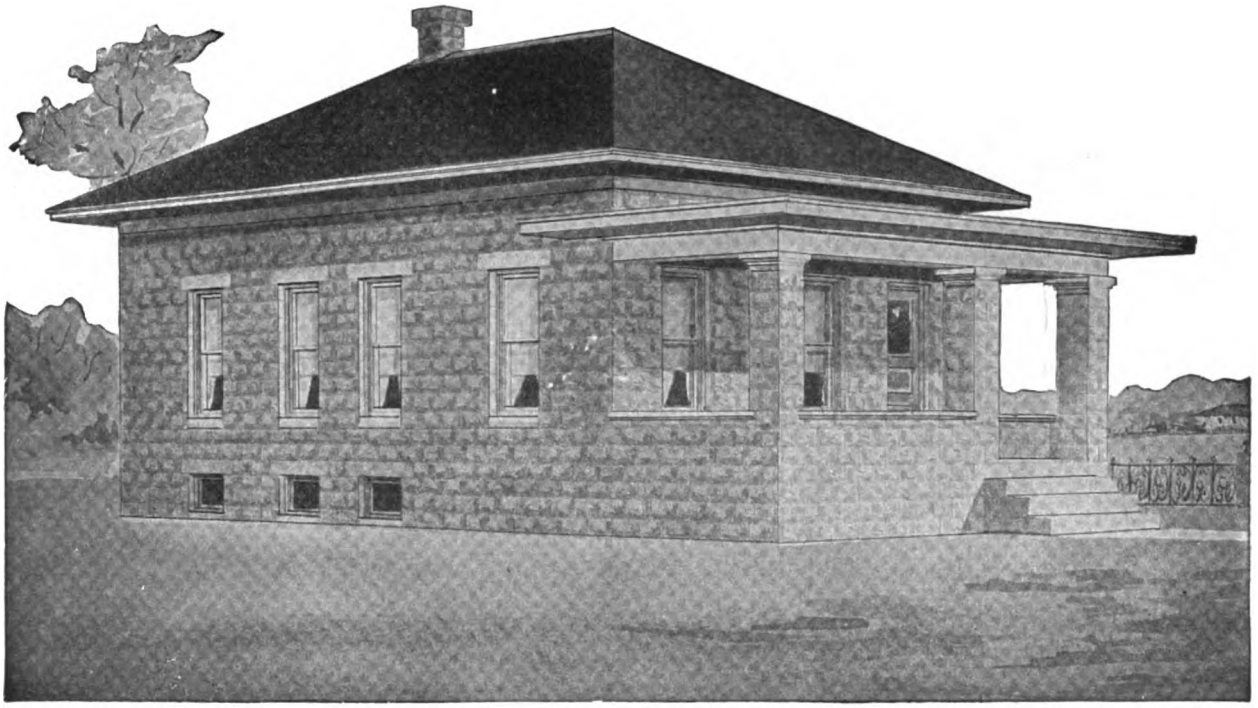
ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



Second Floor Plan

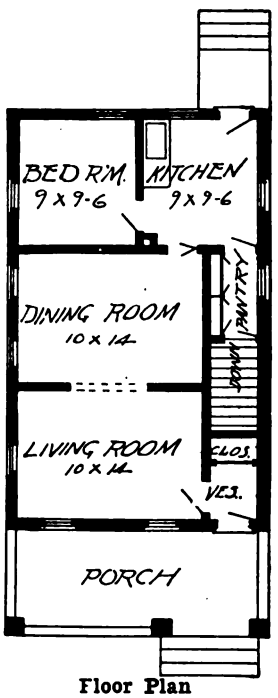
Digitized by Google



Design No. 8195

Size: Width, 20 feet; Length, 32 feet

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.



Floor Plan

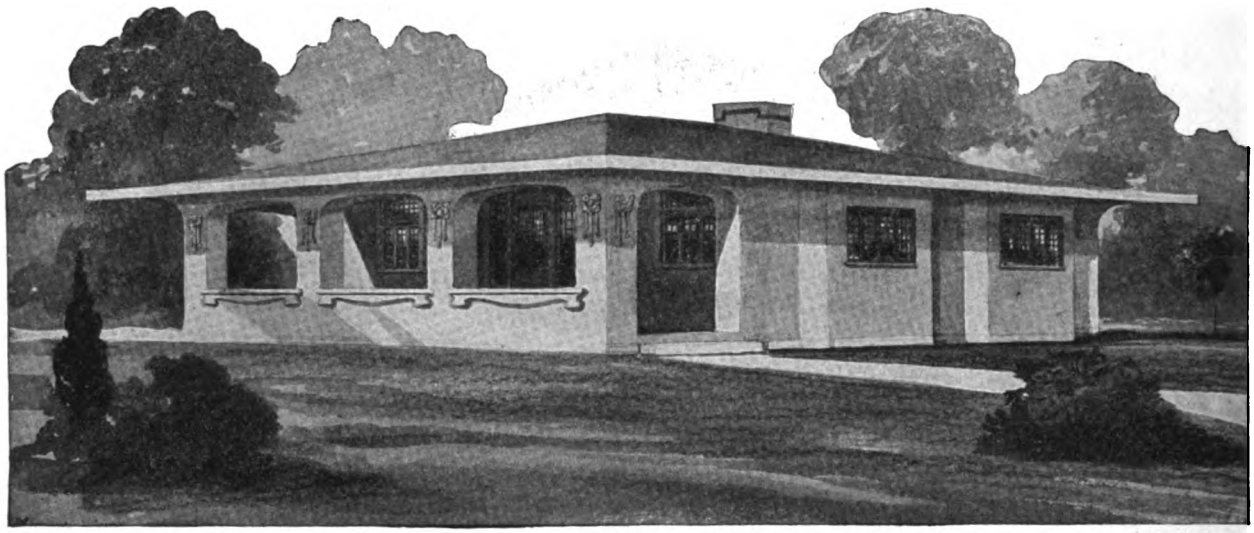
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TEN DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google



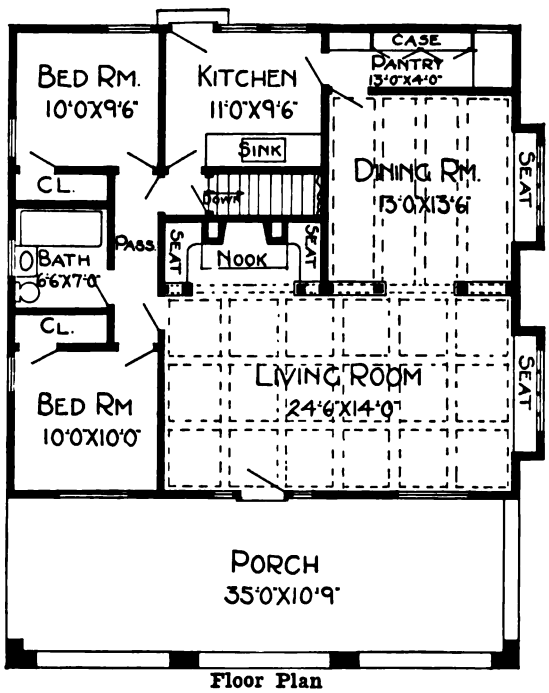
Design No. 8334

Size: Width, 38 feet; Length, 33 feet 6 inches

PRICE
of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

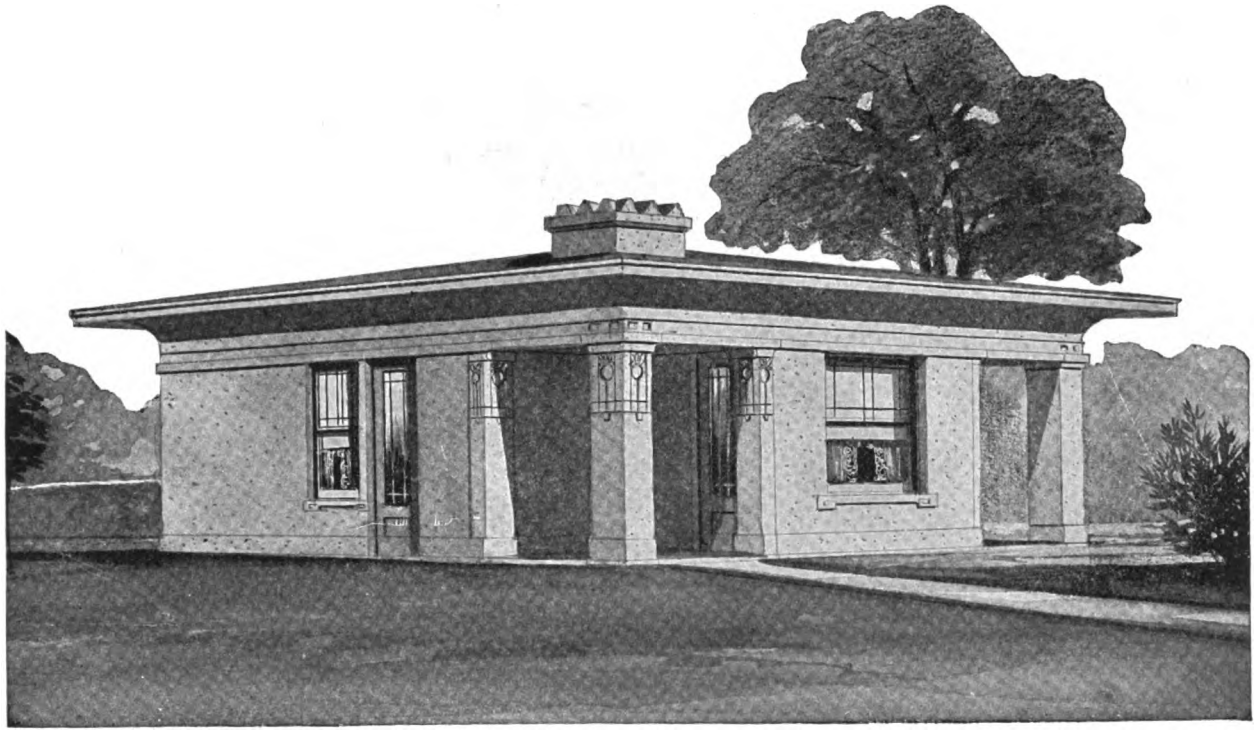
We mail Plans and Specifications the same day order is received.



Floor Plan

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about fifteen pages of typewritten matter.

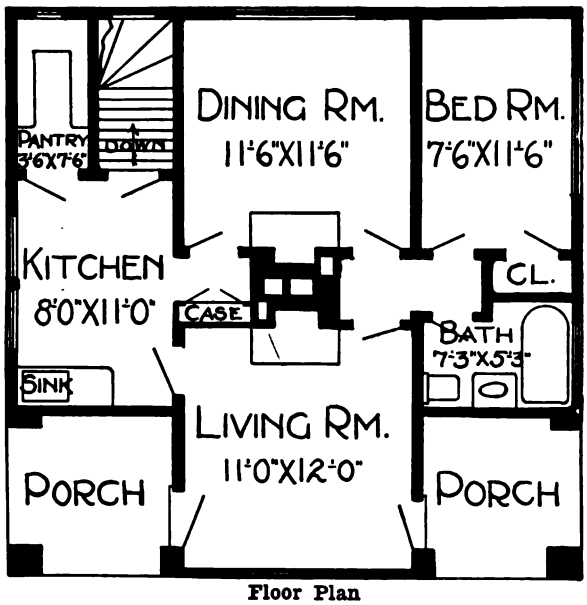
Digitized by Google



Design No. 8335

Size: Width, 28 feet; Length, 28 feet

Blue prints consist of foundation plan; floor plan; front, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.



Floor Plan

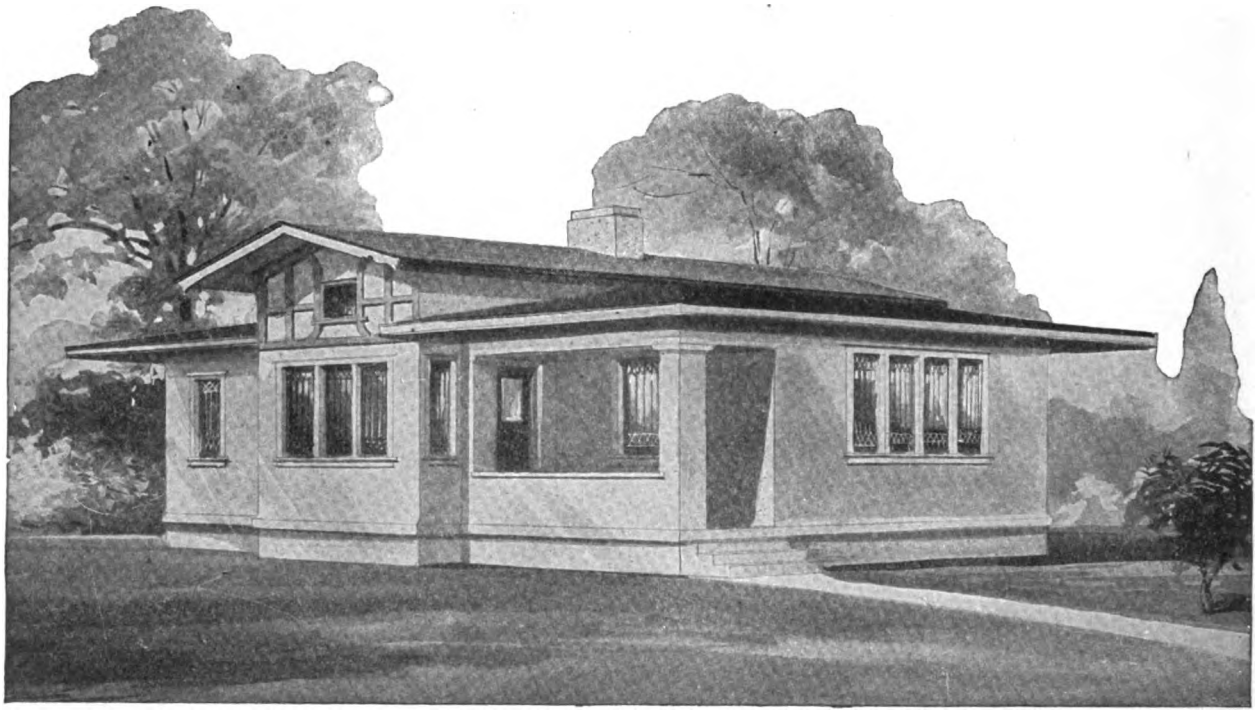
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.

Digitized by Google



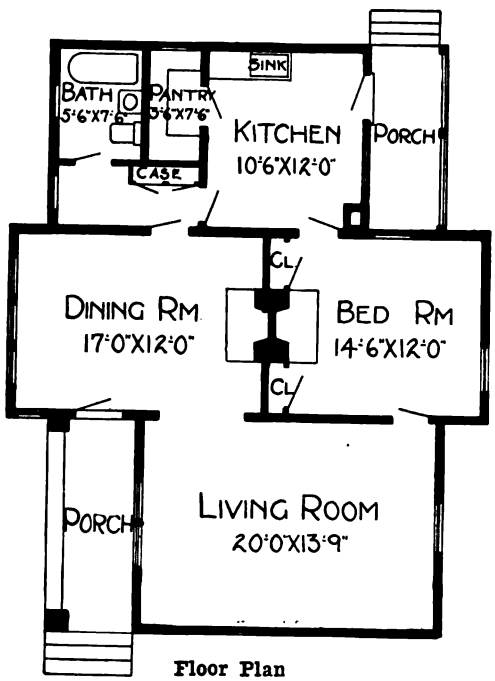
Design No. 8353

Size: Width, 32 feet 6 inches; Length, 40 feet

of Blue Prints, together with a complete set of typewritten specifications

ONLY TWELVE DOLLARS

We mail Plans and Specifications the same day order is received.



Floor Plan

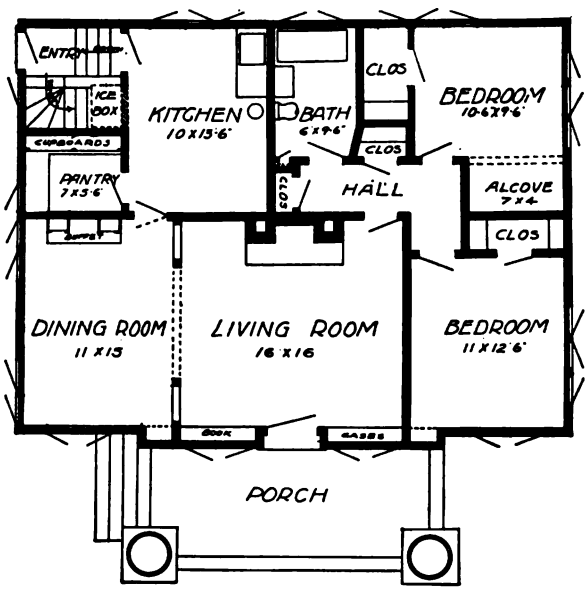
Blue prints consist of foundation plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twelve pages of typewritten matter.

Digitized by Google

Design No. 8356

Size: Width, 40 feet; Length, 31 feet

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.



Floor Plan

PRICE

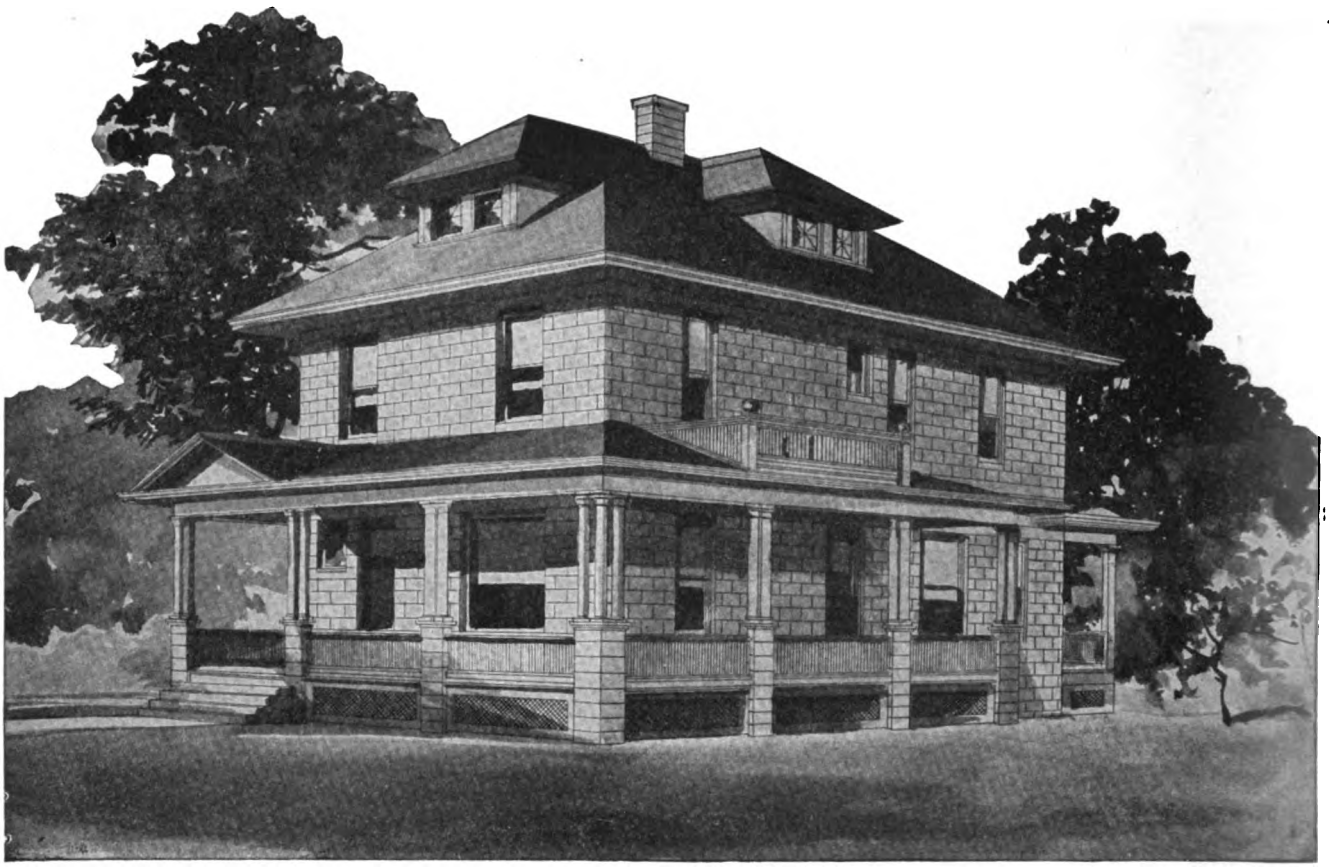
of Blue Prints, together with a complete set of type written specifications

ONLY

$10.00

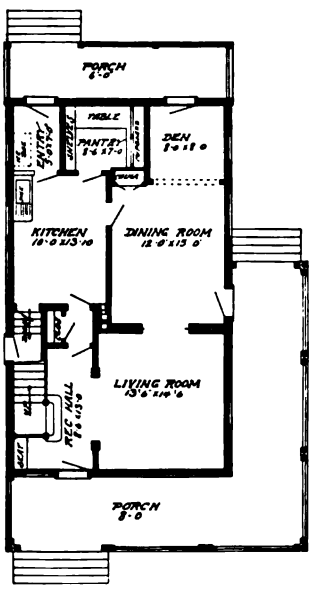
We mail Plans and Specifications the same day order is received.

Digitized by Google



Design No. 8361

Size: Width, 24 feet; Length, 40 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

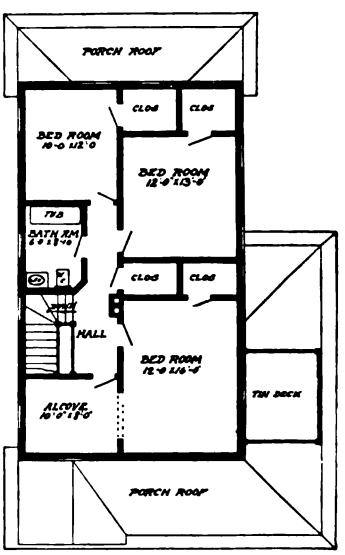
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

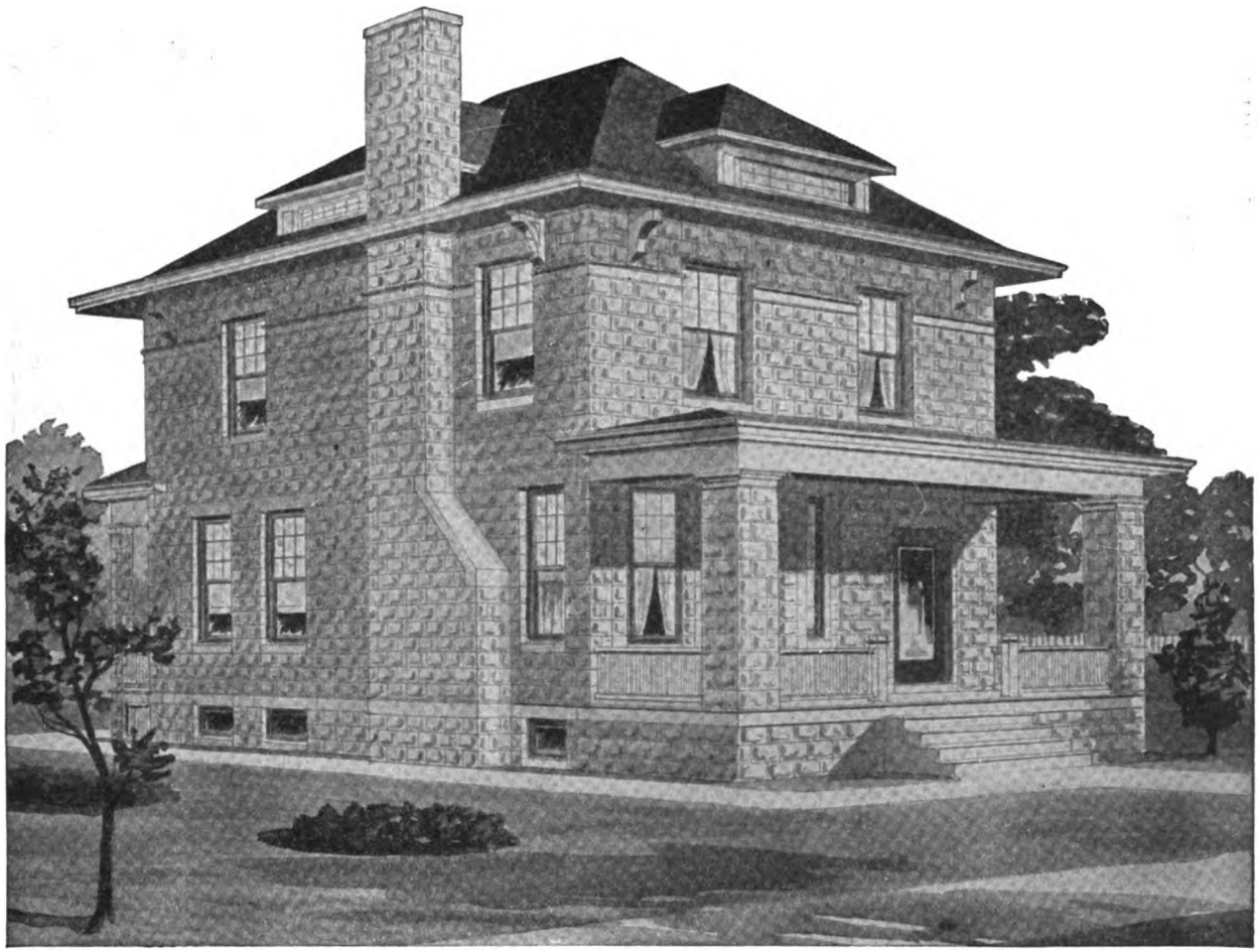
$15.00

We mail Plans and Specifications the same day order is received.



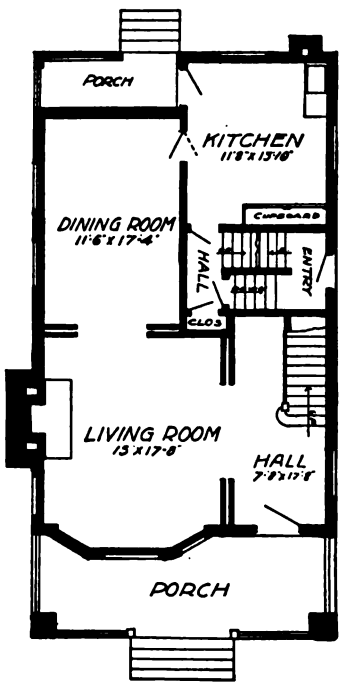
Second Floor Plan

Digitized by Google



Design No. 8358

Size: Width, 25 feet 4 inches; Length 40 feet 8 inches



First Floor Plan

Blue prints consist of cellar and foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

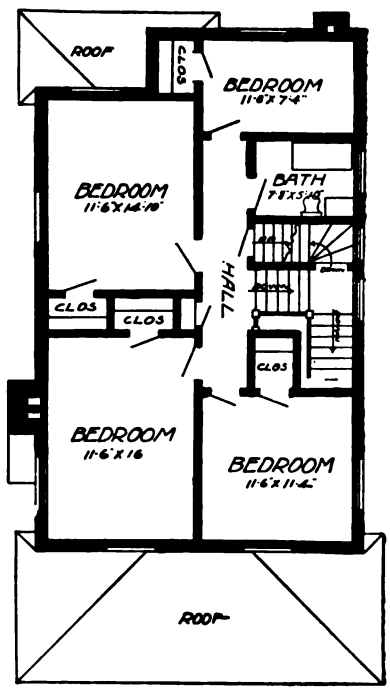
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

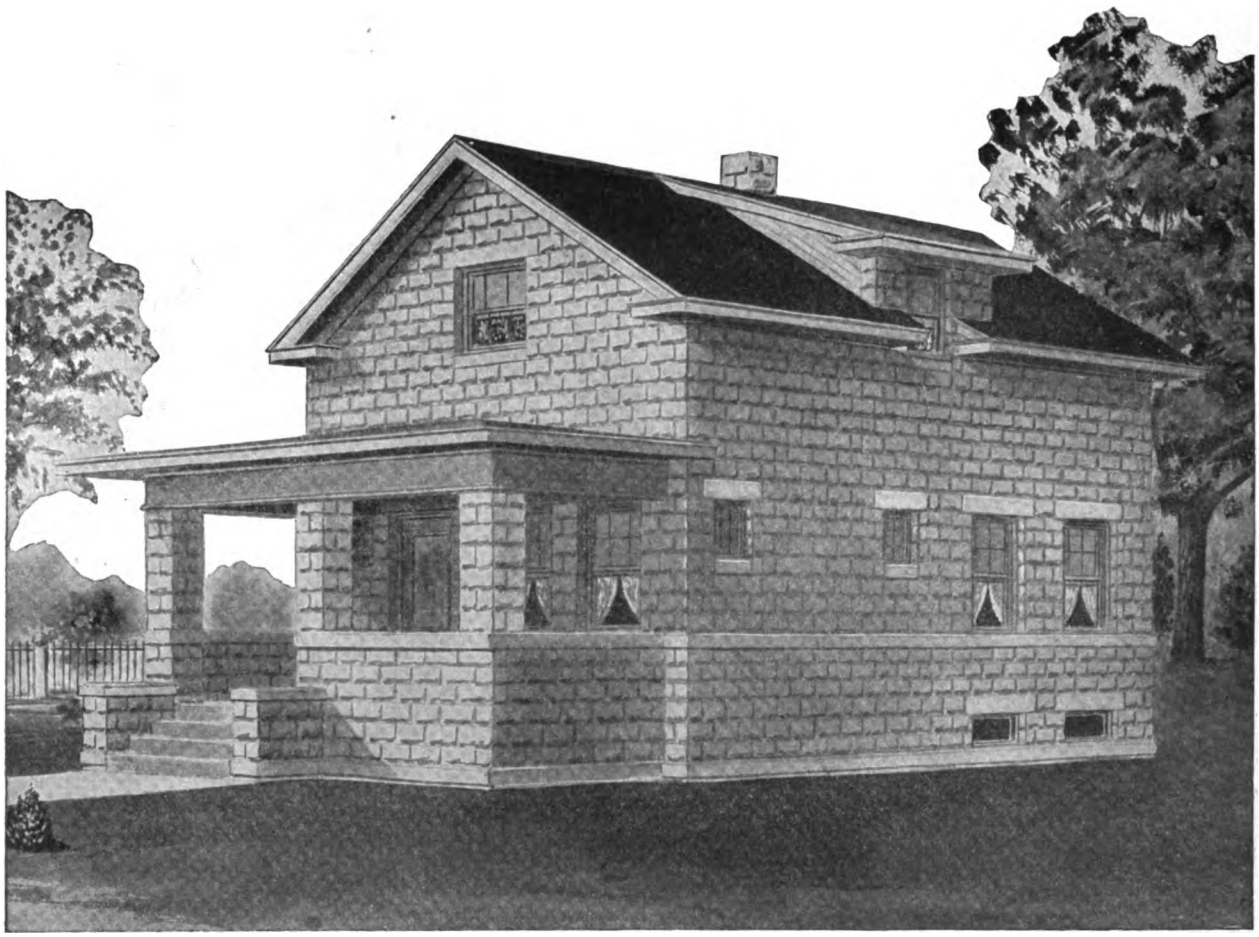
$15.00

We mail Plans and Specifications the same day order is received.



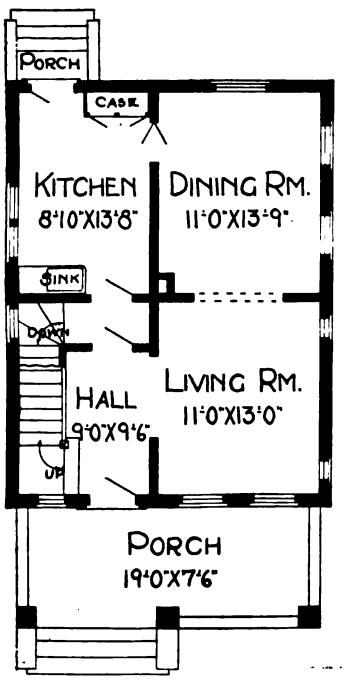
Second Floor Plan

Digitized by Google



Design No. 8360

Size: Width, 22 feet; Length, 28 feet 8 inches



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

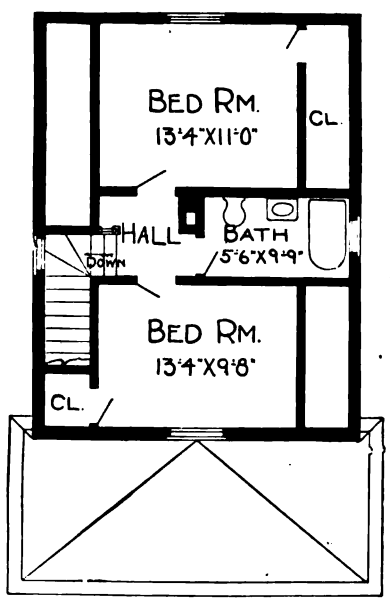
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

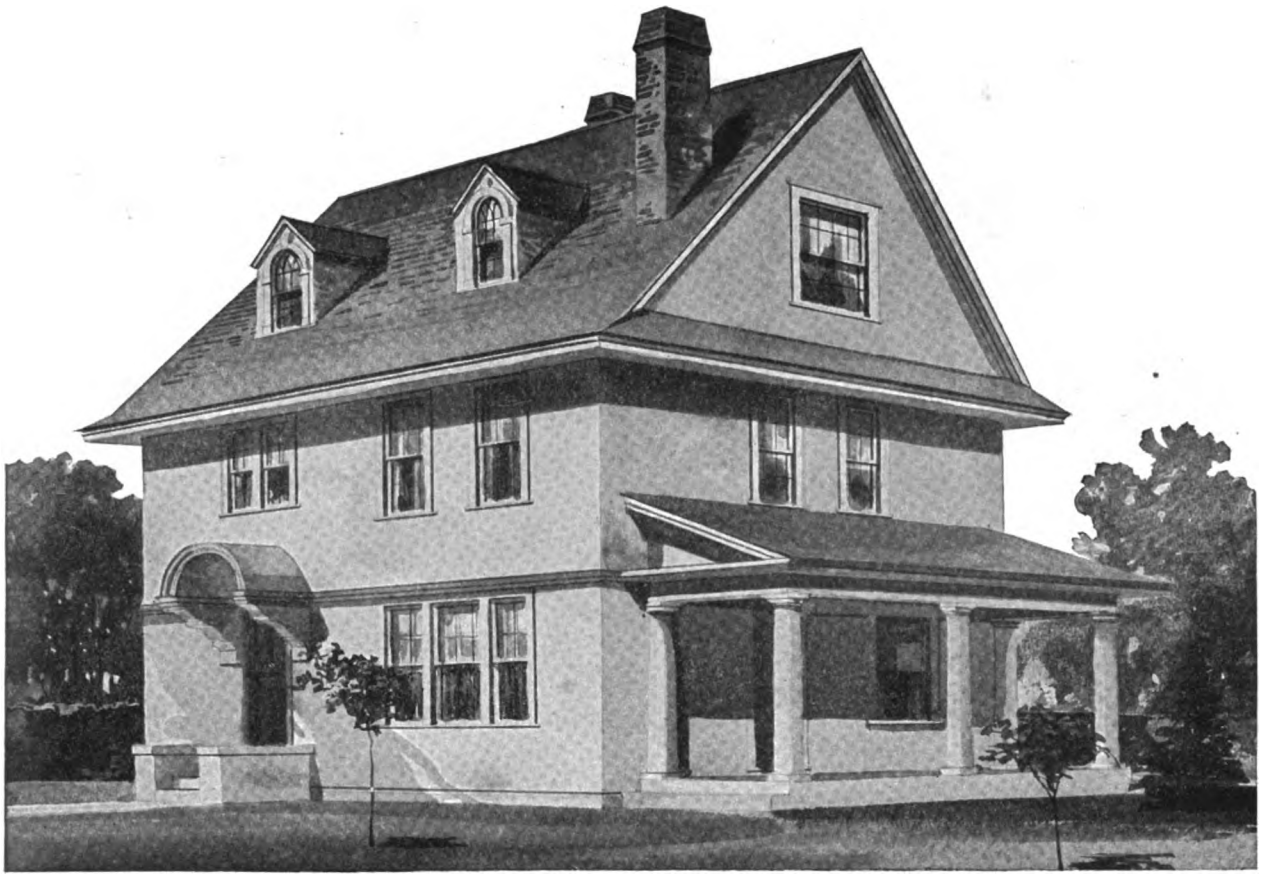
$10.00

We mail Plans and Specifications the same day order is received.



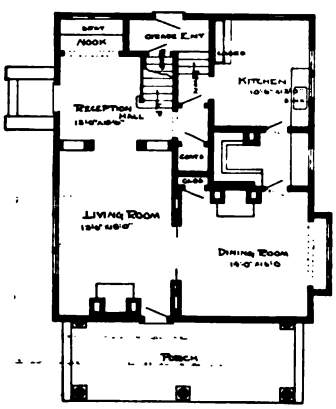
Second Floor Plan

Digitized by Google



Design No. 8354

Size: Width, 28 feet 6 inches; Length, 34 feet



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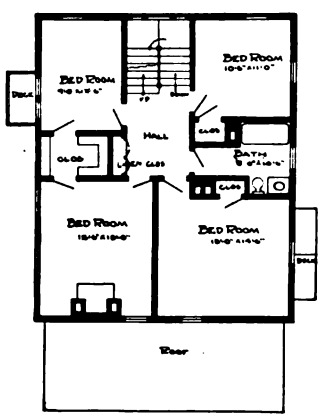

Second Floor Plan

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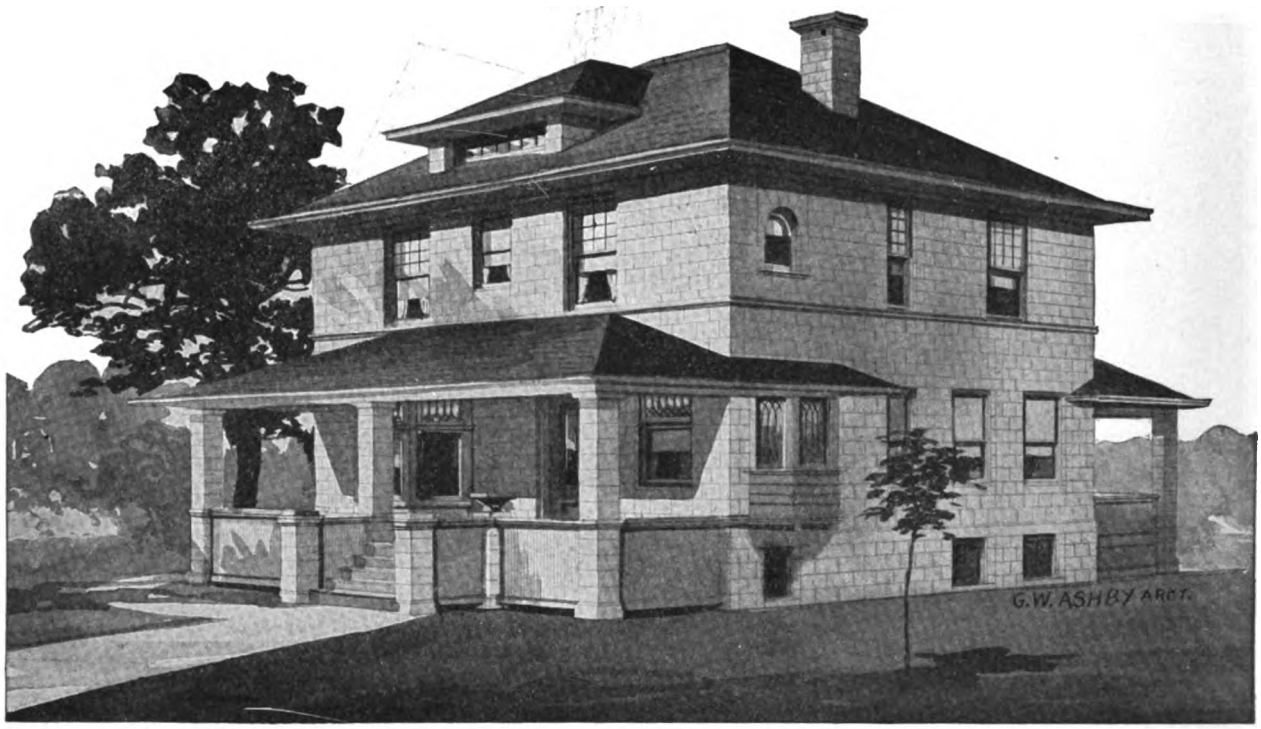
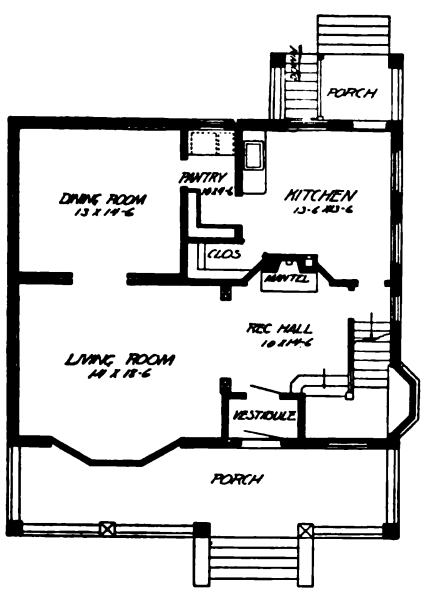


Design No. 2034-B

Size: Width, 35 feet; Length, 31 feet



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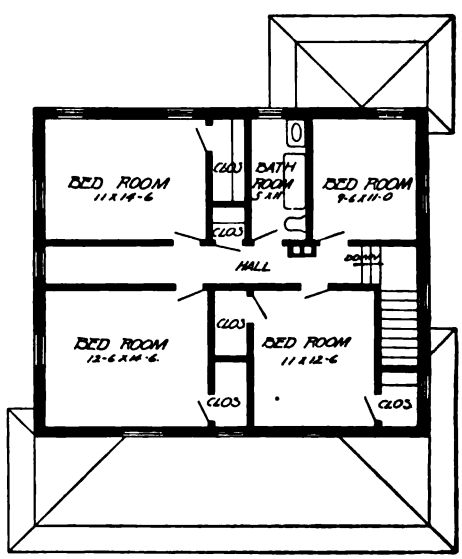

Second Floor Plan

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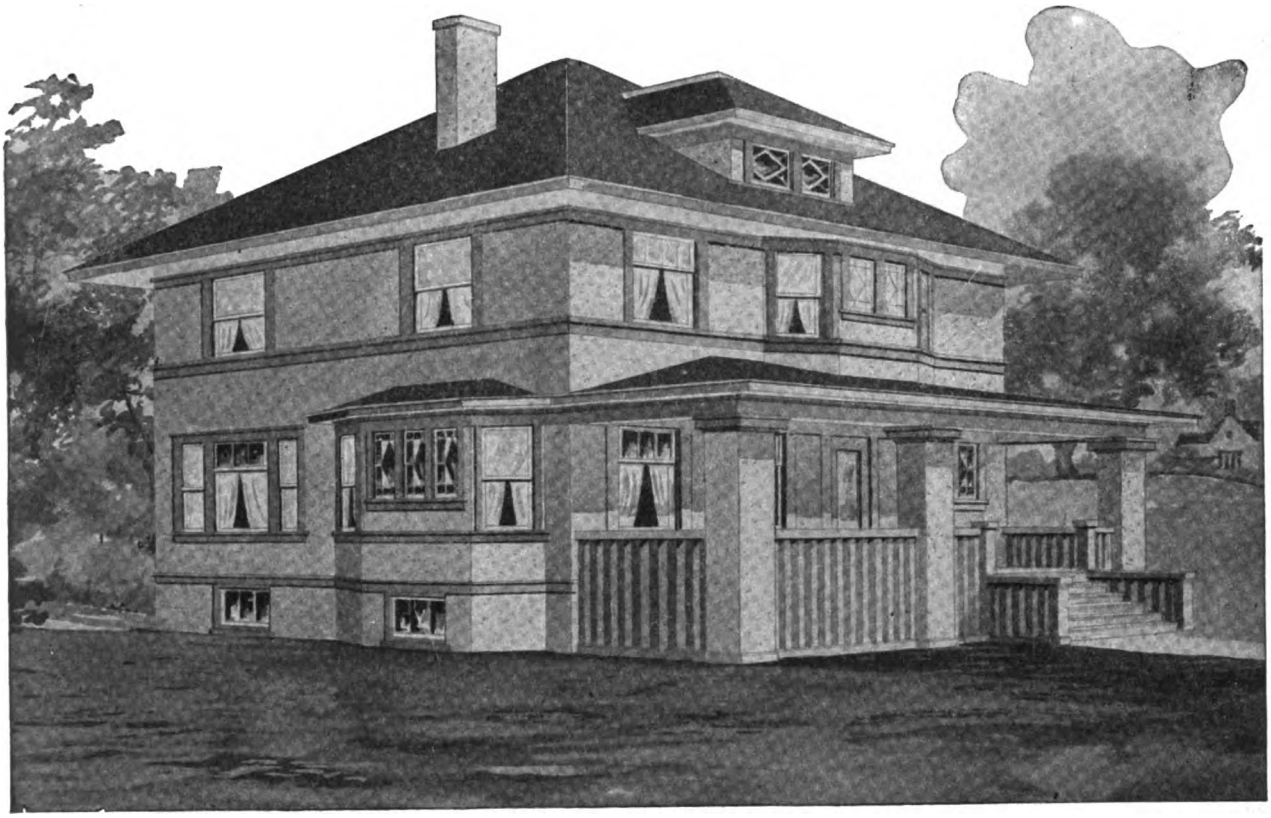

Design No. 8357

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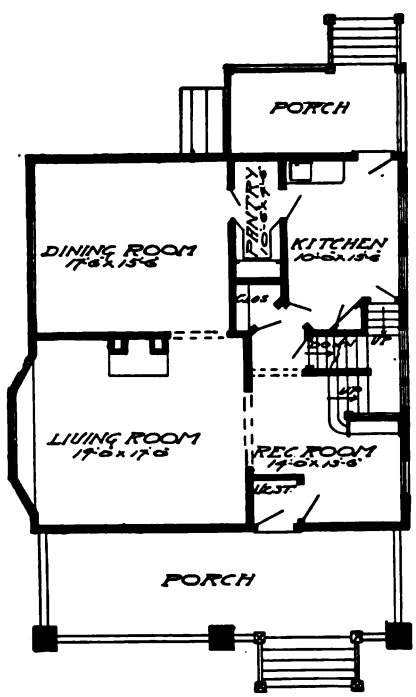

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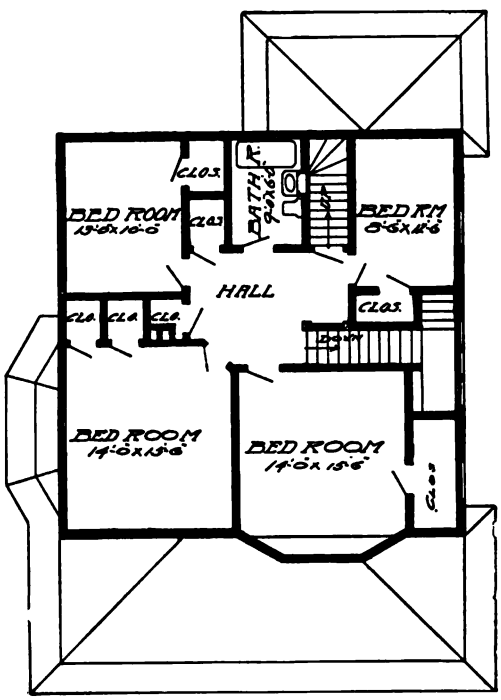

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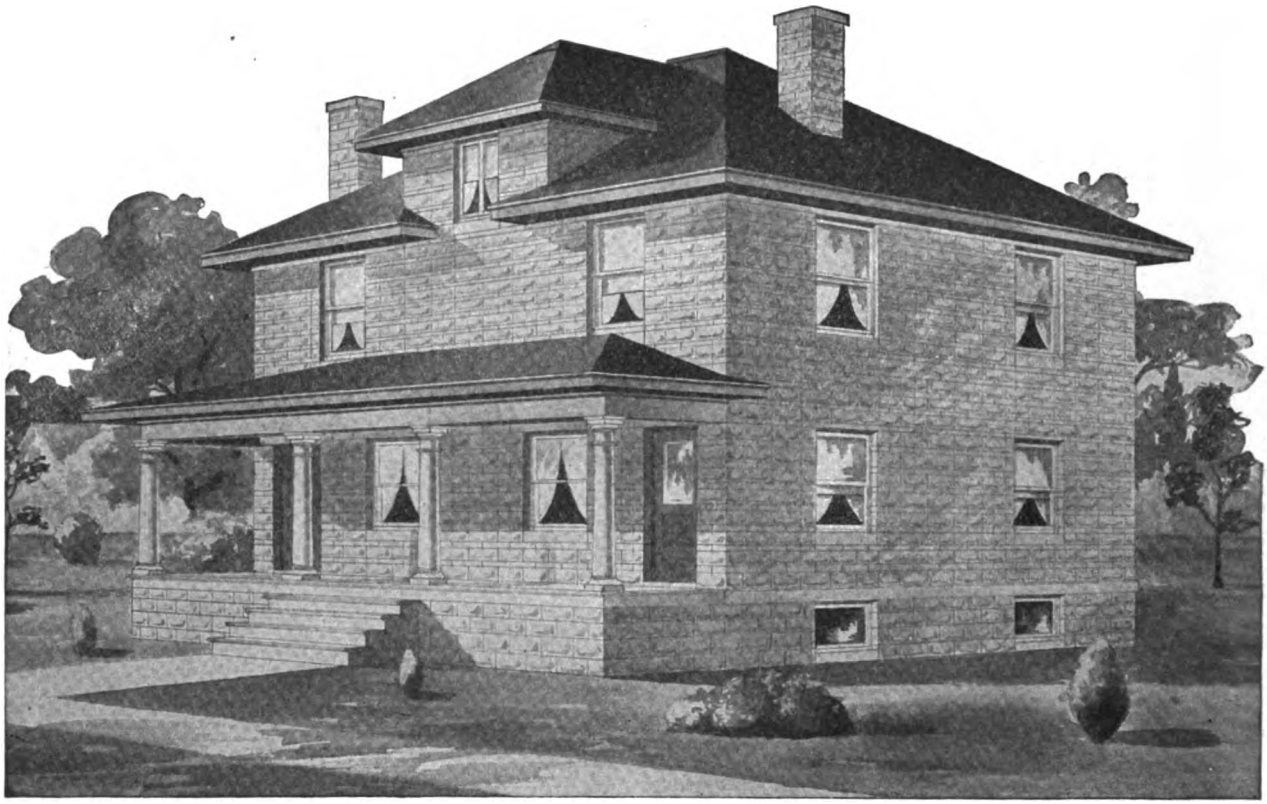
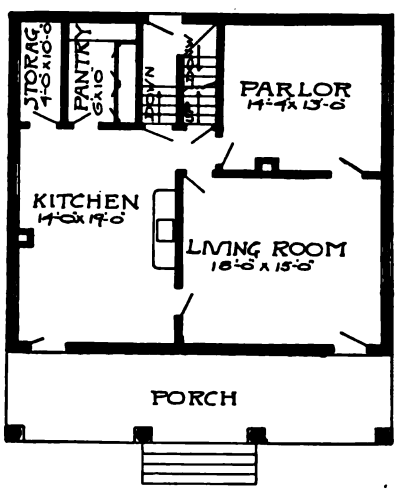


Design No. 8355

Size: Width, 34 feet 4 inches; Length, 30 feet 4 inches



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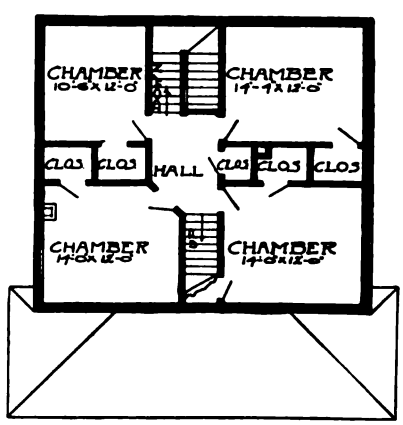

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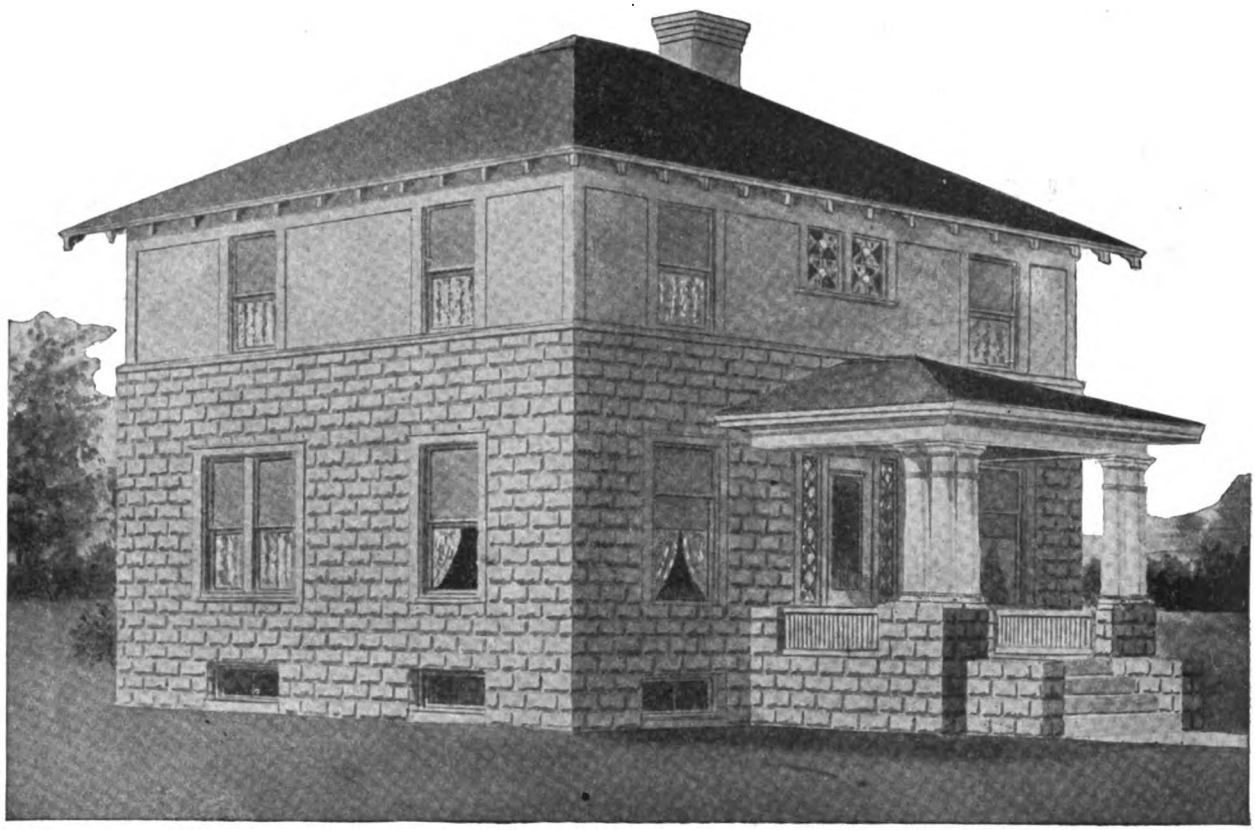
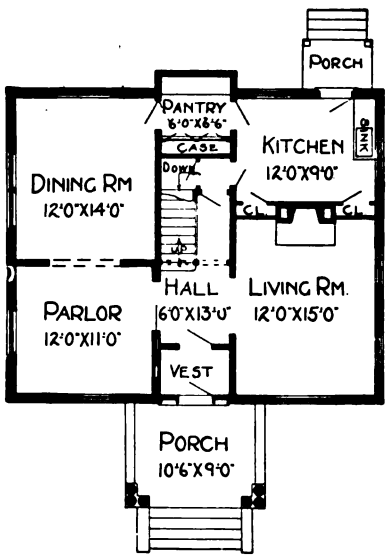


Design No. 8359

Size: Width, 32 feet 8 inches; Length, 27 feet 4 inches



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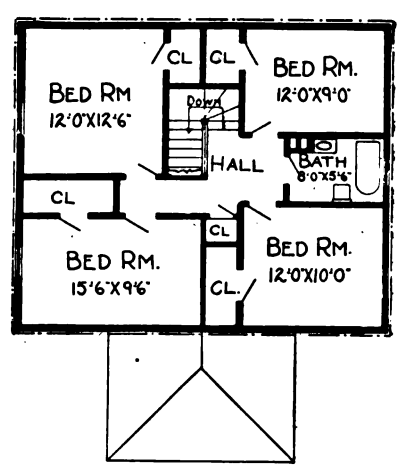

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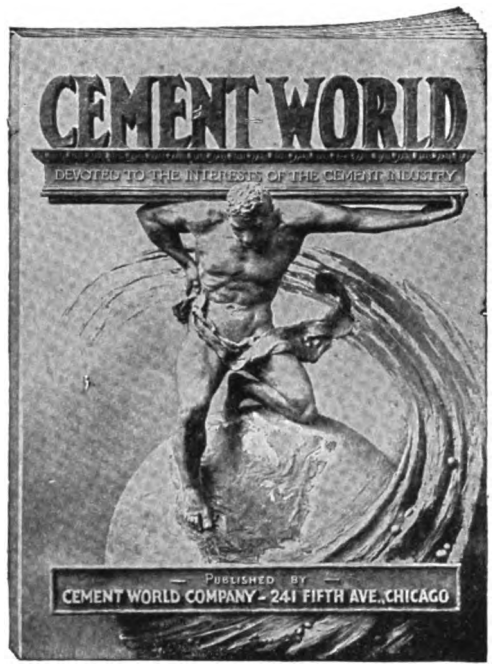

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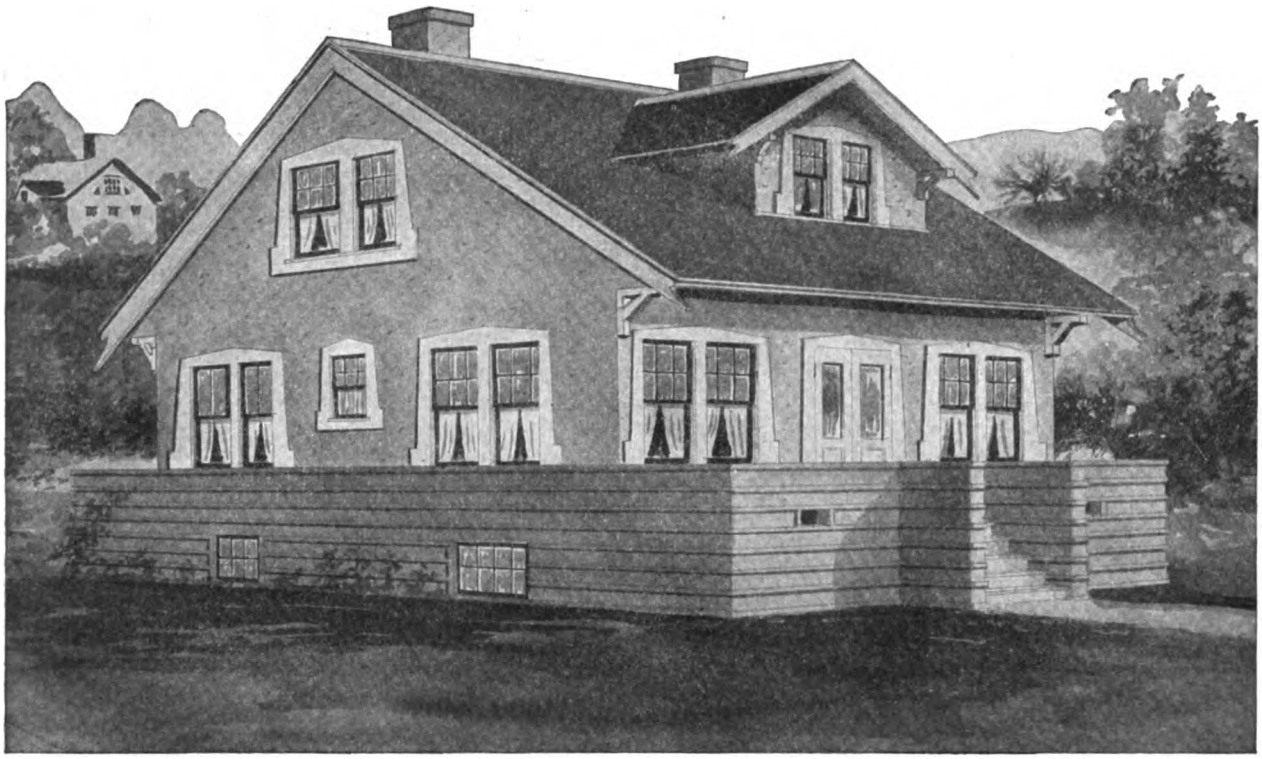

Design No. 8362

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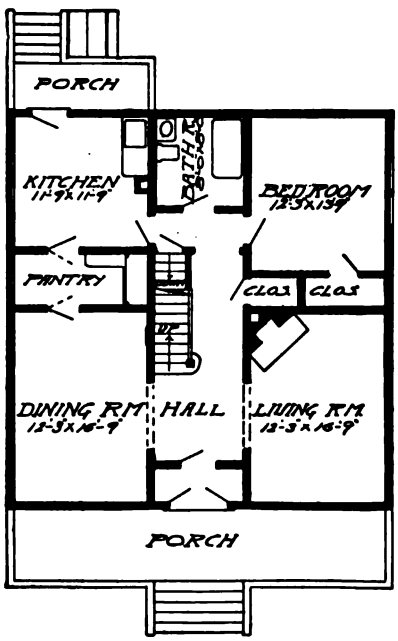

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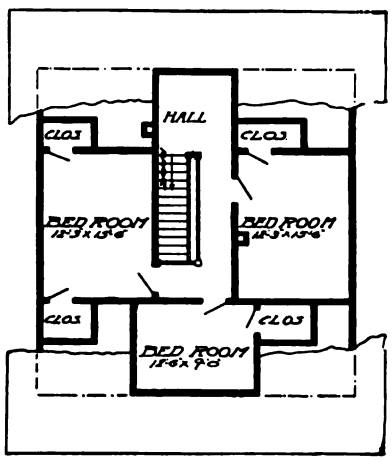

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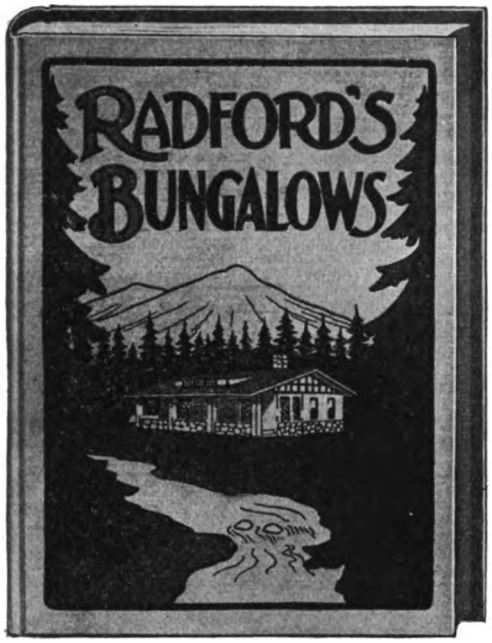

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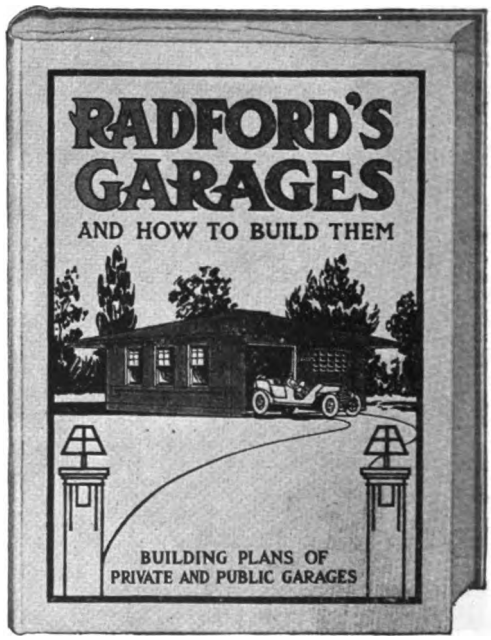

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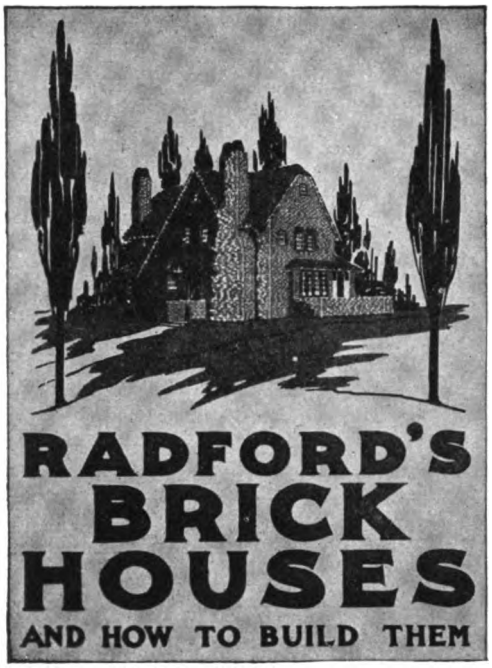

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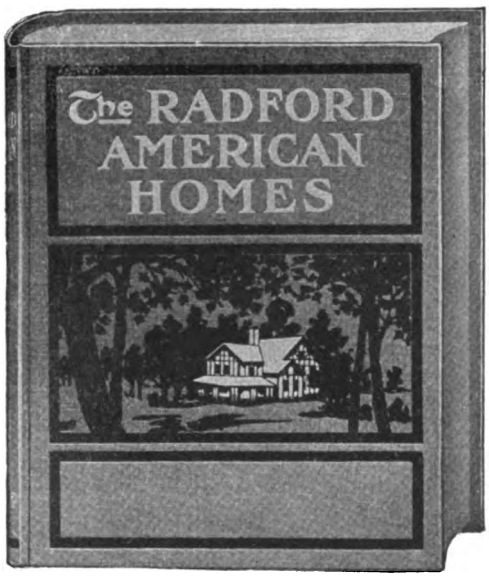

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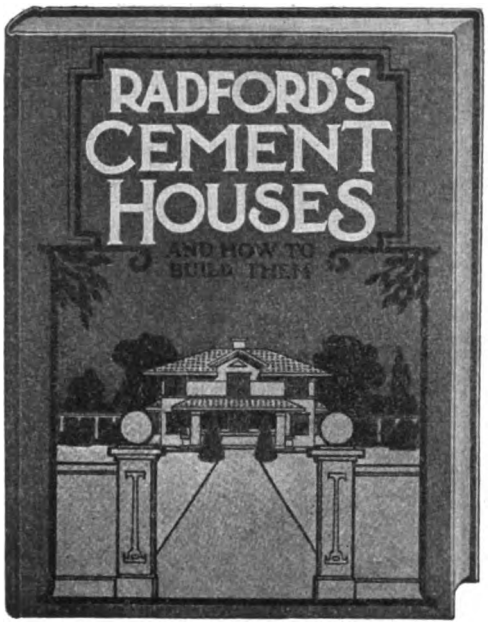

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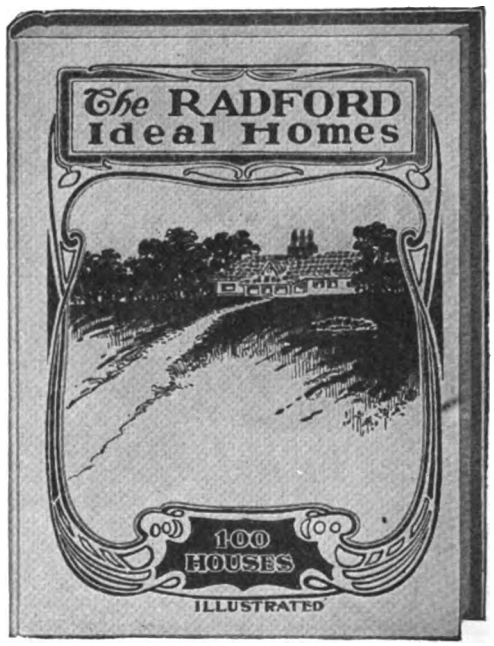

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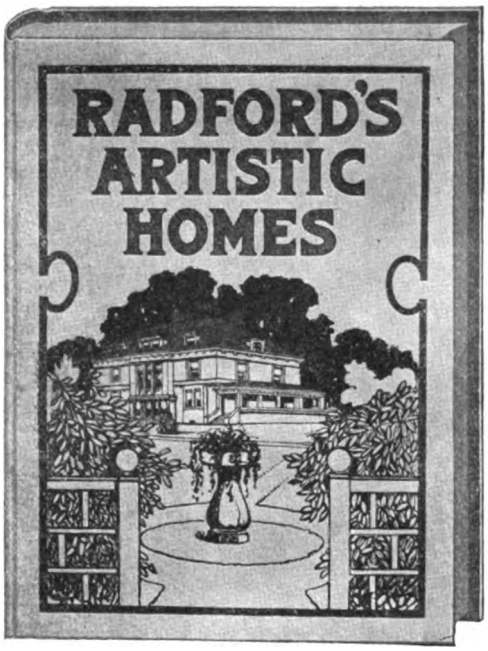

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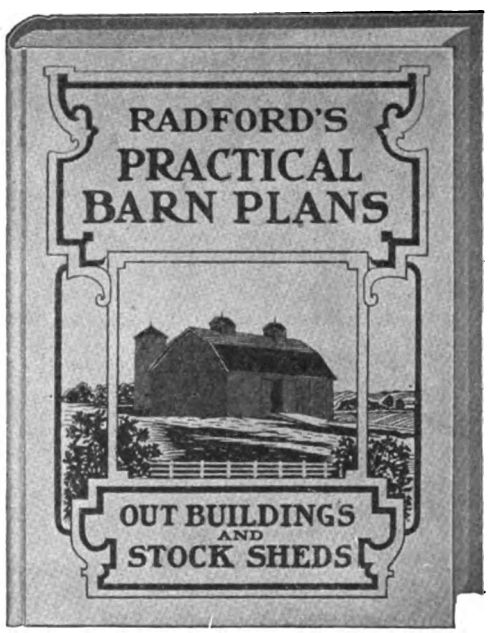

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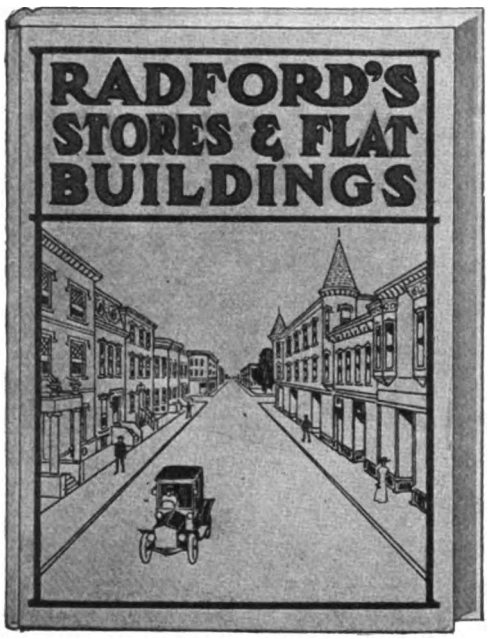
STORES and FLATS



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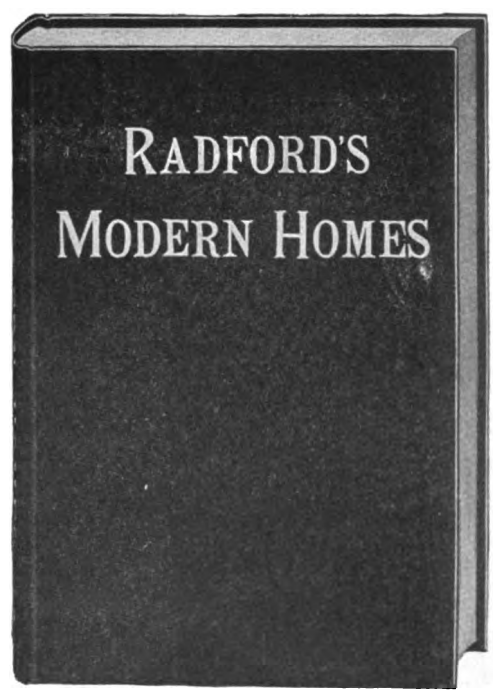

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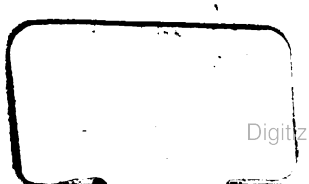

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